FACTORY MANAGEMENT and MAINTENANCE

AUGUST, 1933

Successful Selling Begins in the Plant

UTILITY, appearance, price interest the buyer. No sales department can wish them into what it has to sell. They must be built into the product. That is to say, *successful selling begins in the plant—begins there no matter what the product.* The statements that follow come from manufacturers of such totally different things as glass bottles, smoked hams, machine tools, automobile tires, and electrical goods. They indicate that this approach to today's selling problem is not unfamiliar to leaders throughout all manufacturing industry

Production Management Accepts Responsibility for Sales

H. S. WHERRETT, President, Pittsburgh Plate Glass Company
Pittsburgh, Pa.

THE DAY when the factories of this country turned out products under manufacturing schedules and methods determined largely by influences outside the realm of sales has long since passed. It is a safe assertion that no single group of workers has responded so wholeheartedly to the demands made on it by the new order of things as has production management. The thoroughness with which it accepts its definite sales responsibility will have even more to do with success of the sales units in the future than it has had in the past.

We have long considered that successful selling is a necessary and important objective of production. The resulting advantages are so marked that we are constantly on the alert to find new ways by which we can develop the interest of the factory personnel in the problems of the sales department. We have found in most cases that the factory men not only respond quickly to the approved demands of the trade as expressed through the sales department, but frequently anticipate them with refinements in the products, improvements in packaging, and in ways calculated to facilitate distribution, preservation, and use.

Within the past ten years the manufacturing processes of plate glass have been revolutionized. In step with the new process, our technical and mechanical engineers have developed changes in the product which greatly broaden the field of consumption.

Window or sheet glass was formerly made or sold in a manner which might have been expected in view of the term "common window glass," by which it was known to the trade and to the layman. We have taken our product out of the "common" classification. It has been greatly improved by research work and through the use of new machinery, and has been dignified with a trade name.

One of our manufactured products is painters' brushes, which are produced by an industry in which there has been comparatively little modernizing. In this plant, where considerable hand work is still employed, the production management has done a particularly good job of reducing costs. Here again, we have found that the factory men are much more critical of their own work when the product is dressed up and sold under a brand name than when it is just a paint brush.

The new selling recognizes the necessity for increased

values, and this factor applies constant pressure for low costs with maintained or improved quality. Economies in manufacturing achieved through up-to-date machinery and the most efficient processes, supported by attractiveness of the product, by longer life and a widened scope of utility, will help materially to secure increased results from the sales work.

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Superior Products Sell

A. W. Robertson, Chairman
Westinghouse Electric & Manufacturing Company, Pittsburgh

A SUCCESSFUL manufacturer is reputed to have said that if one is finding too much resistance with his products he should go back home to his factory and find out what is wrong. All of which is another way of saying that some products sell themselves and that if there is too much sales resistance there is probably something inherently wrong with the product.

Whether successful selling begins in the research laboratory, in the designing room, or out in the plant, it is certain that sales consciousness on the part of plant managers and their workers performs a very important function today in the successful marketing of manufactured products.

The Westinghouse organization has always believed in the selling ability of a superior product, and at this time stresses the sales advantage of providing the market with superior goods of advanced design. We are in sympathy with your slogan that successful selling begins in the plant, but think it should be made clear as no doubt it will be, that it does not end there in this day when every manufacturer aims at a superior product.

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New and Better Processes

J. D. Tew, President, The B. F. Goodrich Company,
Akron, Ohio

THE MAJOR importance of efficient and economical production of merchandise and rigid maintenance of product quality has perhaps never been more forcefully demonstrated to American industry than during the last three years.

With declining prices in force until 1933, factory management was charged with the responsibility of producing to meet conditions but without compromising the character of the finished product.

In our own organization the production departments accepted the challenge, found new and better manufacturing processes, and in spite of the downward spiral of prices improved the quality.

Selling actually began in the factory, and enabled the sales organization to go into the field with continued confidence in policy and product.

Better Products at Lower Cost

P. E. Bliss, President, The Warner & Swasey Company
Cleveland, Ohio

THE MOST important part of the selling program today is the product itself. If the product is better than in the past, and particularly if it has been produced at a lower cost, sales are possible even under present conditions. Thus, in a real sense, the ability of the plant organization to produce a better product at a lower cost is a vital factor in the success of selling effort, and upon the shoulders of the plant management now rests a real responsibility in connection with the universal effort to rebuild sales volume.

Fortunately, plant managers are well aware of their responsibility and are devoting their best thoughts and efforts to reducing costs, even in the face of diminished volume of production. New methods and processes are being studied, and comparisons are being made of the results of different methods and processes.

The true value of these improvements in plant methods must, of course, be measured not only in terms of production results, but also in terms of the indirect help given the selling organization by putting additional value into the product. A full realization of this double value on the part of plant executives will encourage further study of new methods, new processes, new layouts, and new equipment.

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Today's Job Better Than Yesterday's

G. F. Swift, President, Swift & Company
Chicago, Ill.

TODAY, the selling of Swift's fine foods begins beyond our plants. It begins with the purchase of the raw materials. The quality of the finished food products depends, to a very great extent, upon the skill with which fine live stock is selected. The care taken in procuring raw material is carried into the plant and on through manufacture, handling, transportation, and selling—in fact, through every step until the finished product reaches the retail dealer.

Skilled men of science are constantly at work in our laboratories, searching for ways to make our products better. Every laborer, in every plant, is imbued with the spirit of doing his job better today than yesterday. Further than that, he is always on the alert for new ideas that will improve not only the efficiency of plant operations but the quality of our products as well.

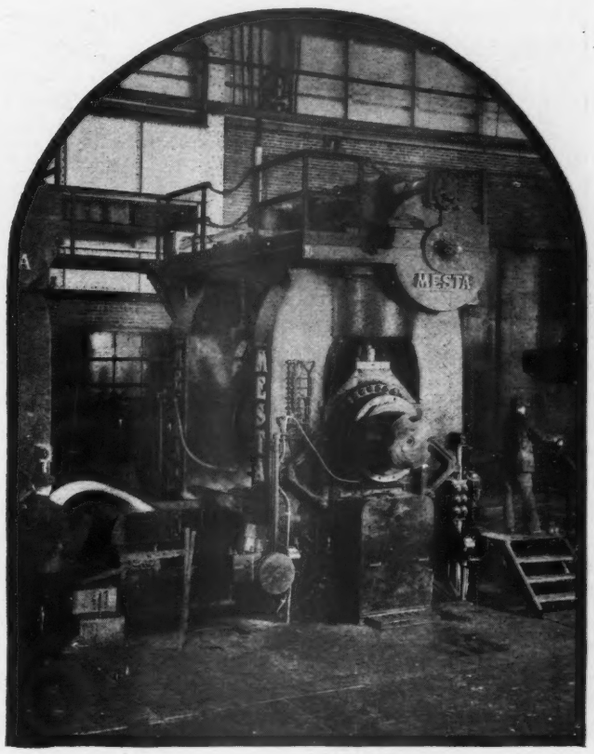
We regard each employee as a vitally necessary unit in performing the total function of making and handling perishable and semi-perishable foods. Everything possible is done to encourage a spirit of interest and loyalty to the ideal established by the founder of our business.

That, I believe, is the foundation of good selling.

New Equipment, New Processes New Products That Sell

Inland salesmen are backed by a modern, trouble-free mill which they know can deliver quality products at costs that can face competition

H. P. Dutton
Associate Editor



INLAND STEEL'S new hot strip mill at Indiana Harbor, Ind., is an addition to the company's capacity rather than a replacement. Recent improvements make possible the continuous rolling of steel, not only at a lower cost than with hand-rolling methods, but with a resultant finish and uniformity of gage which could be obtained under the old methods only by repeated and costly cold rolling. The new mill, which embodies these improvements in a completely modern plant, thus opens markets for automobile-body, furniture, and other high-finished sheets in which the company had not previously been able to compete effectively.

The new mill is only one unit in an extensive program of development and modernization which was started at the very beginning of the depression and has gone steadily forward in spite of it. This program gives eloquent testimony to the importance attached by the company to modern equipment, efficient processes, and a complete line of products in capturing today's and tomorrow's markets.

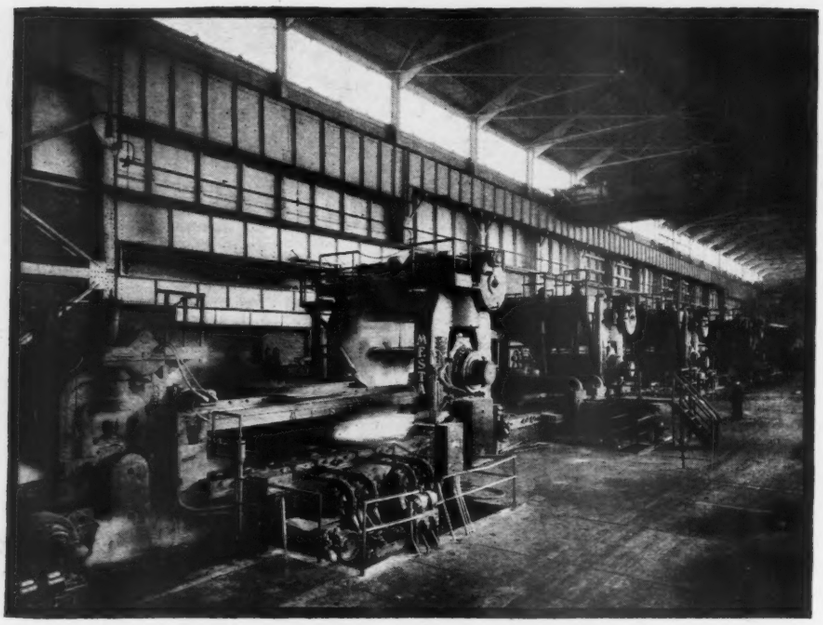
In hand rolling, the slab of steel is given from three to five passes in a breakdown stand, and is then reheated and given several passes back and forth in the finishing stand. The strip must be started into the rolls for each pass by hand, using tongs, and the length of sheet is limited to less than 20 feet.

In the new continuous mill, the slab leaves the reheating furnace, drops onto a roller table, and is carried continuously through two stands of rolls, roughing and finishing, emerging as a continuous strip up to 770 feet in length. It is then picked up by a set of power-driven conveying rolls and carried to any one of several shearing, leveling, weighing, or coiling units. It may be cut into finished sheets and loaded for shipment before it is cold.

The new process effects several important economies and improvements over the old. Because of the greater length of the strip, scrap at the ends is reduced; an improvement in side rolling also controls the width more exactly and reduces scrap in shearing the sides to width. The elimination of a reheating and the more rapid passage of the materials through the rolls not only effect an economy in heat, but reduce the scaling of the sheet by exposure to the air and thus improve the finish. The almost complete elimination of cross rolling tends to avoid opening seams or flaws in the metal, and the initial rolling is done at a higher temperature, which tends more effectively to close any possible defects existing in the slab.

The finishing room consists of two parallel buildings, constituting one open floor space. The finishing operations occupy one of these buildings; the other serves for the assembly of stock on orders, for shearing to customers' dimensions, and for shipping.

One's first impression is of the great simplicity and



General view of the Inland Steel continuous hot strip and plate mill. From left to right, scale breaker, spreader stand where slabs are cross rolled, hydraulic squeezer to bring slab to proper width, nine stands of roughing and finishing mills. Operators, located in pulpits above the mills, on the walls of the building, get a clear view of what is going on, exercise close control through ammeter and tachometer readings

directness of the process. But at once come questions as to the controls which keep this heavy machinery in running order, insure uniformity of quality, and schedule to advantage the varied orders.

To answer these questions, we may glance first at the plan of production control. The mill rolls to customers' specifications, which may call for a different combination of gage, width, length, composition, and treatment of each lot.

Orders are received by this mill, as by others in the company's system, in the form of hectographed copies of customer's order, on which a letter symbol designates the item for each mill. A "provider" picks off from the orders the items for the hot strip mill and requisitions slabs of the required composition and dimensions, including waste, for delivery at the required date.

Each day a mill schedule is made up of orders to be run that day. In making up this schedule, the order of work must be determined, not only by the customer's requirement, but so as to distribute the rolling with regard to the wear of the rolls.

This schedule is a guide to the foremen in planning their shifts, and to the furnace men in charging slabs. The first order may call for 6 slabs, the next, 21, and so on. The slabs are marked with heat number when received and are checked with the schedule. As the last slab on an order is charged, the furnace helper signals the recorder on the rolling floor.

The recorder counts each slab as it emerges from the furnace, beginning with the first order. As the first slab on an order emerges, he signals the roll pulpits by flashing a light. He also notifies the roll attendants and finishing crews. Rolls and shears are set, and the machies prepared for the next run.

Costs are kept for each order. A chronolog at the roll stands records operating and idle time, and a gang time ticket is punched in and out for each job. Other direct-labor costs are similarly recorded against the individual order.

Control of quality is a second angle of interest. At Inland it does not require less judgment than in older and less highly mechanized production, but that judgment is backed by heavy and therefore rigid machinery, and by precise and automatic mechanical and instrumental controls which substitute certainties for variables at critical points.

Control of temperature is critical in securing uniform sheet, for unevenness in heating the slab means unevenness in hardness under the rolls, in contraction during cooling, and in the grain and working of the metal. Therefore one finds a liberal use of automatic controlling and recording pyrometers and thermometers. Temperatures are taken at selected points in the slab furnace, also in the normalizing furnace through which part of the product passes.

Uniformity of furnace temperature is also secured by the use of a new system of burning gasified heavy oil, which also prevents drops of oil from falling on the slabs and causing oil pits. The furnaces, three in number, are of a 2-zone, triple-fired type. Consumption of oil is recorded continuously and totaled periodically.

Gage is controlled by a pair of motor-operated, magnetic-clutch screwdowns, right and left, which determine the position of the roll bearings. Indicators show gage adjustment of 1/5,000 inch or less; a set of push-button controls starts the motors in either direction, on either bearing or on both at once, and allows easy and delicate adjustment. Gage and width are also checked before the strip is sheared into sheets.

The working rolls on the finishing stand are removed and reground at the end of every 10-hour shift. Backing and roughing rolls are also changed on a fixed tonnage schedule.

The question of quality is closely related to mainte-

Each roll is driven by its own motor, direct-connected through a gear reducer. All motors as well as electrical, hydraulic, and mechanical auxiliary equipment are housed in a power room adjacent to the roll room. Power for the 65,000-hp. connected load is generated by the company, using blast furnace gas and powdered coal as fuel. Regular maintenance schedules for all equipment aim to foresee and forestall rather than wait for trouble

nance, for quality of product as well as continuity and cost of operation depend on the condition of equipment. In a plant where one bad bearing may stop the mill, lubrication cannot be left to guesswork. The roll stands are completely equipped with anti-friction bearings; each stand has its own automatic lubricator system, with auxiliary manual pump in case the oil pump should fail.

Oil at any required pressure up to 1,000 pounds per square inch is pumped to a set of plungers, each of which may be set to deliver a measured quantity of oil to a bearing. Every 15 minutes these plungers discharge and start to refill, and an instrument records the action of the system.

As a further safeguard, each bearing block carries a recording thermometer. The record of temperatures is checked hourly by the attendant; should any bearing show an abnormal tendency to heat, it is investigated at once. Of a pair of bearings on a roll, the right bearing, which is fixed to take the lateral thrust, normally runs a little hotter than the other, which floats laterally. The use of indicating and recording ammeters, often two or three at different control points for a single machine, gives further immediate warning of any increase in load which might result from bearing or motor trouble.

Lubrication of the several hundred motors and roll bearings on the hot tables keeps a man busy each shift, covering the tables according to a regular schedule. Responsibility for all oiling and lubrication is centered in one division of the maintenance department.

Electrical inspection and maintenance is the responsibility of another group of some 15 men, including two power-room attendants for each shift. All motors and other equipment are inspected on regular schedule, the aim being, as throughout the plant, to foresee and forestall rather than wait for trouble.

A small welding gang is kept busy on repairs and changes. Another crew is in charge of all piping and hydraulic, air, and oil connections. A machine shop serves for mechanical repairs. Altogether, from 25 to 40 maintenance men are needed on each shift, out of perhaps 350 employees on both shifts.

Spare pinions, universal joints, and complete motors are carried for the smaller motors used in quantity. For the larger units, spare brushes, brush holders, and a few spare coils are carried. Other spares are carried in quantities indicated by experience. The chilled cast and ground rolls on the hot tables have shown so little wear that they promise to last a lifetime, barring breakage.

The building is of trussed steel construction, with corrugated-steel roof, liberal sidewall lighting and ventilation, and cement floors with cast-iron plates where wear is heavy. The building stands on made land out in Lake Michigan. The mill has a rolling capacity of 100 tons per hour of 16-gage stock in a 48-inch width.

With the revival of business, many companies find themselves with months of accumulated maintenance work ahead of them before they can make a serious bid for new business. Many more have a nominal capacity which is actually obsolete and unavailable because the company has not kept up with process improvements in its own field. While such companies have stood still or slipped behind, this company has gone ahead. The Inland salesman can go after orders with the comforting assurance that he has back of him a modern, trouble-free mill, which can be counted on to deliver a quality product not only on special jobs, but as a regular routine, which is now ready to fill orders with a maximum of speed and certainty, and with a minimum of grief.

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First of a number of articles on production's responsibility for sales. The second is scheduled for early publication

Principal Developments In Plant Service Equipment

DURING the period of low production many industrial plants did not install new equipment, even though it presented splendid opportunities to reduce operating or maintenance costs. Nevertheless, makers of industrial equipment went ahead with their development work, bringing out improved designs that will give better service, cost less to operate and maintain.

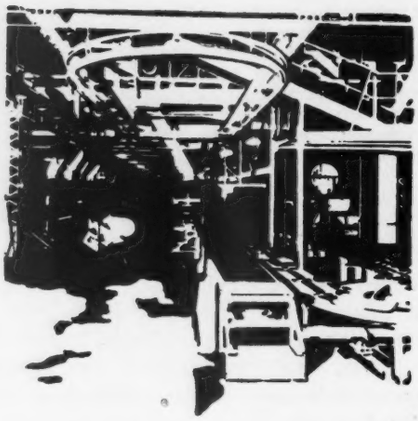
Clouds darkening the business horizon have begun to lift, signs point to brighter days, but the need for industry to take advantage of every aid to lower production costs has in no wise been diminished.

Keeping track of the details and significance of the developments in industrial equipment is important, but not easy. To simplify it, the more important changes in the widely used items of equipment will be summarized in a series of articles, of which this is the first.

Materials Handling

Manufacturers have announced new models of, and refinements in, electric- and gas-driven trucks, industrial tractors, electric and pneumatic hoists, chain-belt and overhead-rail conveying equipment. The developments permit the saving of time and money in handling. Such features as anti-friction bearings, pressure lubrication, and improved chain-link design, have been incorporated, as have improvements in safety, stability, and durability.

Worthy of mention, in connection with safety, is a fast-dynamic braking control for electrically operated crane hoists. It causes the crane to stop quickly and



automatically upon power failure, regardless of the position of the controller handle. Another safety feature is an overload governor for chain hoists, which indicates and prevents loading in excess of 50 per cent overload.

Electric trucks have been improved in respect to hoisting speed and mobility, while tiering trucks have been given greater lifting capacity.

Telescopic tier-lift trucks, on the market for several years, have been developed as to power and lifting ranges. Now available are standard units that can elevate the load to a height of 15 feet. Usually the design provides a set of movable uprights sliding within a pair of fixed outside uprights. They are designed to pass under low doorways, piping, and other overhead obstructions, and yet permit the stacking of objects to the roof, thus conserving floor space. Trucks of this type may be had up to 10,000-lb. capacity. Electric, gasoline-driven, and gas-electric types are available. Some models use a hydraulic lift.

Improvements in speed reducers and drives, which will be considered in a later article, have, of course, been adapted to materials handling equipment. Refinements in control have also been made, especially in the application of phototubes to conveyors.

Ball-and-socket type steering connections, pressure lubricated, have been made standard equipment by many manufacturers, replacing the older pin-and-yoke gravity-oil steering connections. Another development is the design of trucks with interchangeable attachments for gripping, lifting, or stacking. Thus one truck may be made to serve a variety of uses.

In the floor truck field several makers will provide their equipment with rubber-tired wheels.

Design of the motors and controls used in electric hoists has been improved. These units are now available in dustproof and weatherproof types, so that they are suitable for both indoor and outdoor use.

For heavy hauling between factory buildings, gasoline and gas-electric locomotives in any capacities likely to be needed in industrial work are available. The battery-energized electric truck has been developed for heavy duty also, and is used for long, heavy hauls.

An interesting type of equipment for loading or unloading bags, bales, or bundles from freight cars was announced in 1930. It is composed of several sections of spiral conveyors mounted on casters for easy mobility, and is provided with chutes for discharging. By its use bags can be conveyed into the freight cars right to the spot where they are to be piled, and presented to the piler at a convenient height for storing. As one end of the car is loaded the entire unit is moved back; when the center section is reached the conveyor can be turned around into the opposite end of the car.

Slip-sleeve sections of the spiral conveyor tube make it possible for the line to be turned right or left on entering the car door, still keeping the tubes parallel and on constant centers. One man can move the entire loading unit while it is in operation.

Introduced in 1932 was a principle in bulk handling that had been used in England for several years. This principle makes use of the fact that in bulk-material handling, if the boundary layers are urged forward, the entire mass moves as a unit because the shearing strength of the material in itself is greater than the friction of the same material against the relatively smooth walls of a conveyor conduit. Thus, there is now available a conveyor made of square conduit with longitudinally moving elements having relatively light transverse members sweeping the sides. These moving members are square, L-, U-, or H-shaped frames whose perimeters are slightly less than the inside perimeter of the conduit cross-section. Connected by links at intervals of 1 or 2 feet, these frames sweep along the inner walls of the conduit, carrying the bulk material with them.

Such a device is capable of conveying material *en masse* and quiescent at any angle, in any place. It is being used to unload silos of foundry sands, bins of hot ground, coke, or coal, 75-ft. high bins of flour, and for conveying and elevating cement, sugar, starch and the like. Since there is almost no relative movement of one particle on another, the most fragile of these products is carried with practically no degradation. The power required for driving this type of conveyor is low because there is almost no internal friction in the load.

Lighting

The familiar incandescent lamp grows yearly more efficient and, if used at the proper voltage, is capable of giving more hours of service than the older types. Gas-filled bulbs, in place of the vacuum type, have been made available in the smaller-wattage sizes. Advantages of the gas-filled lamp are smaller size for a given wattage; less blackening of the bulbs; longer life; whiter light. Inside-frosted lamps, which are much easier to keep clean than are the outside frosted type, were introduced in 1930.

Lamps have been made available with the lower portion silvered on the inside. This coating reflects the light upward toward the reflector, eliminating glare. The selective reflection of the silver coating gives a light approaching daylight in quality.

There is available an improved type of tubular mercury-vapor lamp, announced in 1932. All terminals are of the screw base, screw-shell type and, by means of insulating covers, are detachable by hand. The reflector design embodies rounded corners, concealed wiring, more reflecting surface than on the old models, and permits complete covering of the tube at both ends—an improvement that should reduce breakage.

During the past few years stress has been placed upon the value of utilizing in industry the healthful properties of ultra-violet light. Small ultra-violet mercury-arc lamps, with screw bases, operating on 30 volts, have been made available. A separate transformer is required for such lamps.

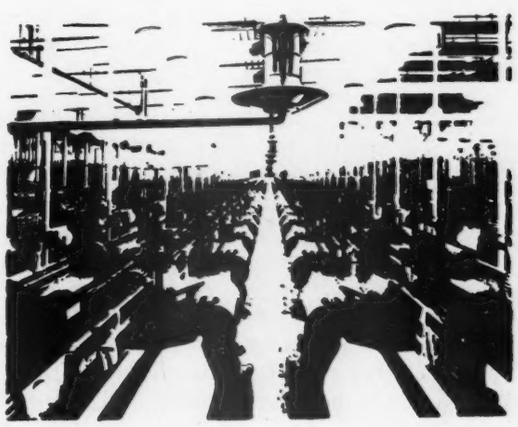
Another ultra-violet lamp contains a pool of mercury and two heater filaments. When the lamp heats up the mercury vaporizes, and a glow discharge gives off the ultra-violet rays.

So-called "duo-purpose" lighting fixtures incorporating two circuits have been designed. One circuit energizes an ordinary incandescent lamp, for direct or indirect lighting; the other lights either a "sunlight" incandescent lamp, or a mercury-vapor lamp.

Lighting Shades and Fixtures—In diffusing and semi-diffusing units, improvements have been directed mainly toward making reflectors and fixtures more easily removable to facilitate cleaning and maintenance.

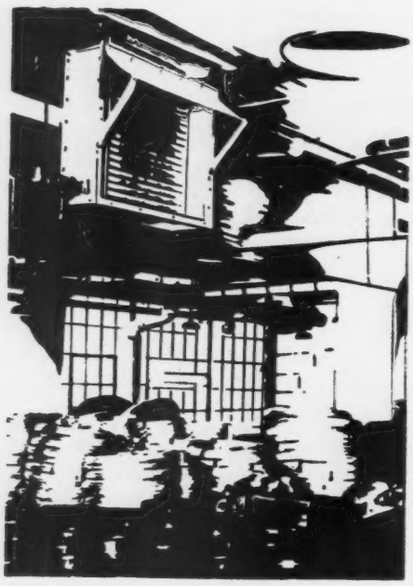
Perhaps the most significant trend in lighting is the greater attention that is being paid to the solution of specific lighting problems, resulting in the development of equipment designed for the purpose.

Paint and Illumination—During the past few years paint manufacturers have become increasingly aware of



the part which their product plays as an adjunct of the lighting system. Mill whites that have excellent properties for industrial use and a long-time guaranty against yellowing are now available. Manufacturers of paint for industrial interiors now furnish tables showing the reflecting values of their products, so that paints of definite light-absorbing characteristics may be chosen. Knowledge concerning the effects of color has increased, and among the manufacturers of paints and ingredients for paints are some who have assembled information along this line.

Heating



In the design of unit heaters there has been a strong trend toward cast-iron or steel-pipe coils instead of copper coils. Otherwise, improvements revolve largely around fan design. Most manufacturers now have distinctive developments as regards blade pitch, curvature, hub speed, and the like, for which they claim individual advantages and points of superiority.

A departure in method, announced in 1930, is the so-called "air-blanket" system, wherein a blanket or ceiling of low-temperature, fast-moving air is projected horizontally over the breathing zone of the room or building, for the purpose of holding down the warm air issuing from the unit heater in that zone. The advantage claimed for this method is that it enables the warmed air to give off its heat without the usual loss incident to ordinary methods of heating.

Clock control is available whereby any or all units may be shut off entirely, or the steam regulated for low-temperature operation during certain hours of the day and over week-ends.

During the past four years the so-called "zone orifice" method of controlling radiation systems has been developed. This method embodies a central control board, from which the amount of steam entering radiators in specific areas is regulated. In one type, traps on the individual radiators are eliminated Orifices at all radiators are designed so that, with a definite maximum pressure imposed at the zone control valve, only that amount of steam which they can condense will flow to the radiators. Since each radiator will condense all of the steam supplied to it, there is no need for a trap at the outlet.

At pressures below maximum less steam will flow, and the radiator will be partially heated. Thus, by controlling the steam pressure to any zone, the heat delivered to it may be regulated as desired. The reduction valve for each zone may be automatically controlled by means of a motor. In some installations control is made dependent upon outside temperature variations, rather than upon the temperature at some point in one room.

Air-Conditioning

The term "air-conditioning" is used by manufacturers and users to include a wide variety of equipment. Admittedly, each kind of equipment mentioned here is not considered as capable of controlling temperature, purity, humidity, and movement of the air with which it has to do.

The familiar suspension-type unit heater has been made available for connection to brine solutions or cold water during hot weather. A typical unit of this sort is adapted for the circulation of cold water and sodium or calcium brine, by direct connection to refrigerant pipe lines, as well as steam. In appearance, this heater, with its louvers, blow-through propeller fan, motor, and extended-fin tubes, is no different from the ordinary heating type except that a drip pan is provided for collecting the moisture that condenses on the coils.

In a typical floor-type unit for cleaning, moistening, and heating the air, a revolving drum, which consists of air washer and scrubber plates, is propelled by the air current through the unit. These plates, continually dipping in a water tank, provide a wetted surface through which the air must pass twice. Dirt picked up from the air settles into the water tank and can be washed out through the drain connection by lifting the revolving drum and the hose connection. The water level in the tank is maintained automatically by means of a float.

Aside from the air-washer cleansing unit, types employing filters of various sorts are also available. Since these filters clean without the use of water, the moisture content of the air is not changed. Viscous filters are available which clean the air by causing it to impinge on an adhesive surface. Dust and dirt in the air, especially soot and carbon, are trapped and retained by successive impacts on oil-coated surfaces.

(Continued on advertising page 30)

Now You Must Control Your Labor Costs

With the NIRA's acceleration of a century-old trend, industry must learn how to make a profit in spite of higher wages and shorter hours. The point is, wages must go up, unit labor costs down. This seemingly paradoxical situation can be met by means of balanced rates, wage incentives that limit unit cost but increase production and earnings, efficient clerical and sales effort, modern cost finding and control

Charles H. Hatch

Vice-President, Miller, Franklin & Company, Inc.
New York, N. Y.

BROAD-GAGE factory men, who back their hard-headed business sense with a knowledge of sound economic theory, are not at all worried over the prospect of being required to raise wages and reduce hours of work under the National Industrial Recovery Act. Many of them, forced by cutthroat competition to reduce wages to sub-depression levels, welcome the prospect of raising wages materially and at the same time being protected against ignorant and predatory competitors who look on starvation wages as the sure road to profits.

It is evident that the worker who splits his 24 hours between sleep and work has no time to consume anything much beyond food and work clothes. To make profitable business we must have well-paid consumers who have leisure in which to wear out tires and automobiles, to burn up gas, to read books and magazines, to listen to the radio, to play games, and to dress up on days other than the Sabbath.

For nearly a hundred years the trend has been gradually but steadily toward higher wages and shorter hours. The census indicates that in 1849 the average annual wage of factory workers was $247; in 1899, $427, and in 1927, $1,300. In the same time hours fell notably. Striking are the figures for machinists. In 1849 some of them put in as much as 84 hours a week. The average was 68, the minimum, 60. For such long hours they were paid a maximum of $15, a low of $6, and an average of $9. Fifty years later, 1899, they put in an average of 54 hours a week for an average wage of $14.04. But in 1923 the work week was down 10 hours more, to 44 hours, and wages were up to an average of $40.92.

Even without the National Industrial Recovery Act, this trend would continue, although the process would undoubtedly be much slower. But with the law's emphasis on increased purchasing power and more widespread employment it is certain that all businesses are faced right now with the need of learning how to make a profit in spite of higher wages and shorter hours. They simply will have to improve their methods.

What, then, can the individual business do to lower its costs?

1. Wage scales must be in balance, not only within the plant but in relation to other wages in the locality, and to some extent in relation to the scales of the entire industry.

Transfer of skill from the man to the machine is, of course, the history of the past fifty years, yet we frequently find men being paid as skilled craftsmen when actually they are mere machine tenders. In one plant the skill needed in certain highly paid operations was 40 per cent less than it had been when the scale was set, yet no change had been made.

One concern, forced by the depression to reduce costs, found its wage structure was badly out of balance. When proper rates were set, the payroll of around $3,000,000 a year was reduced by 11 per cent in spite of the fact that certain rates were raised as much as 23 per cent. A similar study in another shop reduced the total cost by 13.5 per cent. Both of these companies, it should be remembered, were not strangers to modern methods.

It is to be noted that in no instance were flat wage reductions made. In the balancing process which I ad-

vocate, I want to emphasize that the balancing will in general be up, not down. Of course, a few cases may come to light where a rate is outrageously high and should be reduced, but mostly the balance will be achieved by raising those rates which are too low. The point is that *labor costs must be reduced, but not wages.* They must go up.

2. Wage incentive plans for both productive and non-productive labor must be devised and installed to stimulate production and to limit the cost per unit of output.

On the face of it, it would seem that a piecework plan would automatically limit the cost per unit for productive labor to the set piece rate. It does not. Learners must usually be paid on an hourly rate. So must time spent waiting for work. There is spoilage in later operations. Always there are various allowances, which all add up to make the cost per unit higher than the piece rate. I have seen actual labor costs as much as 10 per cent higher than the piece rate, theoretically the limit.

Hourly, or daily, rates are still the rule for non-productive labor. In the early days the installer of wage plans often found it beyond his power to devise incentives for non-productive workers, and so left them on straight hourly rates. And the cost accountant, not being able to devise a measure for the activities of those workers in relation to the product, casually tossed non-productive labor into departmental expense, where it was buried.

There are ways, however, by which both productive and non-productive labor can be stimulated with wage incentives, and the labor cost of a product can be definitely held below a predetermined maximum.

With the understanding, therefore, that any method must be closely fitted to particular conditions, I am going to describe one that worked for a manufacturer of electrical equipment. In fact, it clipped $91,000 a year from a payroll that had been $750,000. It was not done by a wage cut. Rather, wages of individual workers were raised from 8 to 27 per cent. Clerical effort has been reduced. Discontent due to inequalities in wages has been eliminated. And the cost per unit of both productive and non-productive labor is definitely limited.

The plan involves considering a major division of a department, or in some cases a whole productive department, as a unit and paying the entire unit a bonus for increased productive efficiency.

All employees are paid a minimum basic hourly rate. For achieving certain standards of production they are paid a bonus of 30 per cent. To stimulate the group of employees to achieve the maximum possible production, the unit is paid a further bonus amounting to half of the difference between actual labor cost and the standard product cost. The total of the hourly rate, and the two bonuses are the most that the company can be called upon to pay, thus limiting definitely the per piece price of a unit of production.

The unit bonus inspires the workers to keep an eye upon every element of labor cost and to be self-policing. If one employee tends to be slack, his fellows suffer. And they are better able to catch the slacker than any foreman or supervisor. They know the hideouts where a smoke can be safely enjoyed over the morning paper. Foremen turn their hands to productive work if needed. No productive worker is too proud to do a bit of trucking or other non-productive work.

When work runs low, the workers are prompt to see that the hours are reduced in correct proportion. The old hands see that the learner is costing them money, so pitch in and do a quick job of teaching. Thus they come to appreciate the high cost of labor turnover and do their best to keep it low.

All shifts participate in the bonus. Therefore each shift sees to it that machines are in order for the next, so that there will be no lost time. Formerly the day men had no interest in the night men and much time was wasted. In short, every single workman is interested in doing all he can to keep costs at a minimum.

3. Get value received from office and sales help.

In almost any concern critical study of office work will pay good dividends. Duplication of effort, over-elaboration, and downright useless statistical work and routine exist far more often than most executives realize.

In one company, which was not unusually inefficient, the savings made in the office work amounted to more than $130,000 a year. Two office departments were combined, with the result that 28 clerks do the work that formerly took 46. In another department the clerical staff has been reduced to 82 from 124. The cost of operating the cost system has been cut 41 per cent; the results have been improved. Useful productive work was found for the clerks whose old jobs were eliminated. The cost of the product was reduced so much that sales increased and the company now employs more people than before.

In selling, great inefficiencies are the rule. It pays, of course, to select salesmen and supervisors carefully. Then put them all on an incentive basis. Aim, as in factory incentive, to devise a plan which will definitely limit the sales expense per unit of sale and in turn control the cost per customer. See that there is no duplication of work, that the efforts of the sales department are coordinated with the factory and financial departments.

4. Methods must be used which will give close, accurate, and current control over all labor costs in factory, office, and sales.

With the house in order so far as labor costs are concerned, it is important that management have a way to see that it remains in order—in short, a control mechanism which will enable management to know accurately just how costs are running.

Modern cost-finding methods make the providing of such figures easy and inexpensive. They go hand in hand with correct wage incentives. Cost figures are no longer purely historical. Now it is possible to know daily, if necessary, the divergence of actual costs, up or down, from the standard. To secure labor control reports daily for about 400 employees should be a full-time job for one clerk—a modest price to pay for tight control.

Some such control is more and more necessary as wages rise and production increases. To be of the greatest value, remember, it must be preceded by an intelligent study of labor payment. Get base wage scales in balance, put non-productive labor as well as productive on a wage incentive—then you will be able to raise wages intelligently and safely.

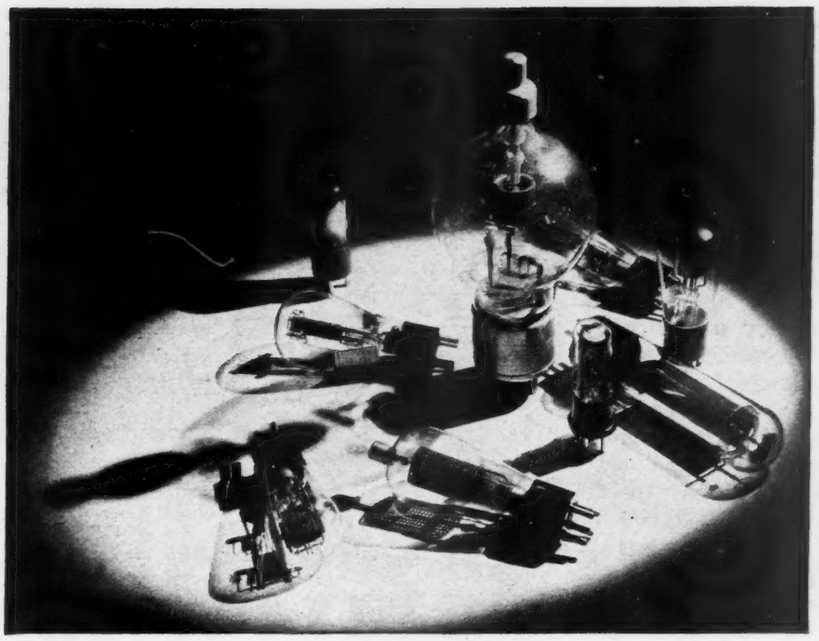


Figure 1. Brains and nerve centers of industrial electron tube devices. The tube in the center is the latest development in power tubes

Stretch Your Electronic Dollar

Correct installations and intelligent maintenance mean better service, longer life from electronic equipment

L. R. Harness

Industrial Sales Department
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

RAPIDLY increasing use of electronic-tube devices has made necessary a better understanding of their installation and maintenance problems. This type of equipment has almost unlimited possibilities because of its versatility, but applications sometimes are unsuccessful on account of improper installation and insufficient attention thereafter.

One of the most common causes of trouble is failure to follow, or even read, the installation instructions supplied by the manufacturer. Usually, these instructions are both complete and concise; only a few moments are required to learn the important points to be observed in making a trouble-free installation. The first important point in making an installation is, therefore: Read the instructions! Much time and trouble will be saved if this is done.

Electronic equipment is designed for several different classes of service. Figure 1 shows a photo-electric control device which is designed for operation under normal indoor operating conditions, but cannot be expected to give, under adverse conditions, the performance obtainable from the heavy-duty, weatherproof unit shown in Figure 2.

With electronic-tube devices that make use of a light beam, both light source and photo-tube must be rigidly mounted and properly aligned, for successful performance. Also, instructions regarding the maximum permissible spacing between light source and phototube and the focusing of the light beam must be carefully observed.

When possible, the phototube should be installed above the light source, so that it is pointed toward the floor and away from overhead lighting. Also, install the equipment so that a minimum of steam and dust will intercept the light beam; they may cause faulty operation.

Many reliable manufacturers of industrial electronic equipment use tubes that are designed and manufactured solely for such applications. These tubes are much more sturdy than their radio forefathers and can therefore be used in places where more delicate tubes cannot be used. It is desirable, however, to mount tubes and other parts of the equipment which might be affected by vibration so as to secure as favorable conditions as pos-

sible. If necessary, spring or shock-absorbing mounting devices should be used.

Operation of some types of electronic tubes is affected by temperature and temperature changes. In making applications, the maximum range of the ambient temperature should be checked; if it appears to be extremely wide, the temperature characteristics of the tubes and equipment should be investigated. Ventilating fans can be used to advantage where temperatures are too high, or heaters where lower temperatures are encountered.

On applications where electronic equipment is required to operate with a very high degree of precision, the effect of line voltage variations cannot be ignored. Figure 3 shows the equipment that regulates the cutting of printed paper, cellophane, and the like, into sheets for wrappers or bags. Since the material often is traveling at 500 to 750 ft. per min. and the cut must be made within $\frac{1}{16}$ in., plus or minus, the apparatus must function with a high degree of precision. If line voltage variations greater than specified by the manufacturer are encountered, a suitable voltage regulator must be used.

Nearly every piece of electronic apparatus has at least one adjustment which must be made when it is installed. Usually screwdriver slots are provided for making adjustments when the installation is made and at infrequent intervals afterward. Adjustments that must be made more frequently, as on paper cutter regulators, are usually provided with knobs, visible on top of the tube panel in Figure 3, for convenience. The purpose of each adjustment must be studied and the adjustment made as directed.

Maintenance sometimes presents a unique problem, since the service man may feel handicapped by his lack of knowledge and experience. Fortunately, this type of apparatus does not require frequent servicing if it has been properly designed and installed, and is not called upon to perform heavier or more exacting duty than that for which it was designed.

Specific recommendations of the manufacturer with regard to maintenance should be followed carefully. To obtain the best results from any equipment, electronic-tube devices included, regular inspections are necessary. The length of time between inspections will depend upon the nature of the equipment and its function. Devices that use carefully adjusted and calibrated circuits will almost always require much closer attention than those used for general relaying and control functions. The former type will generally require rather careful inspection at least once each week and a general inspection once each day. Monthly inspection will usually suffice for the latter type of equipment.

Routine maintenance inspection usually involves watching the operation, correction of any troubles, and replacement of any parts sufficiently worn to cause possible failure. This is essentially all that need be done with electronic devices. The apparatus should be inspected to see that leads and connections are in good condition, that terminals have not become loosened, that the tubes are well seated in their sockets, and that no dirt or moisture has collected in places where it might cause trouble by leakage. Since resistances on the order of millions of ohms are often used in these circuits, dirt or moisture can sometimes cause considerable difficulty if not properly removed.

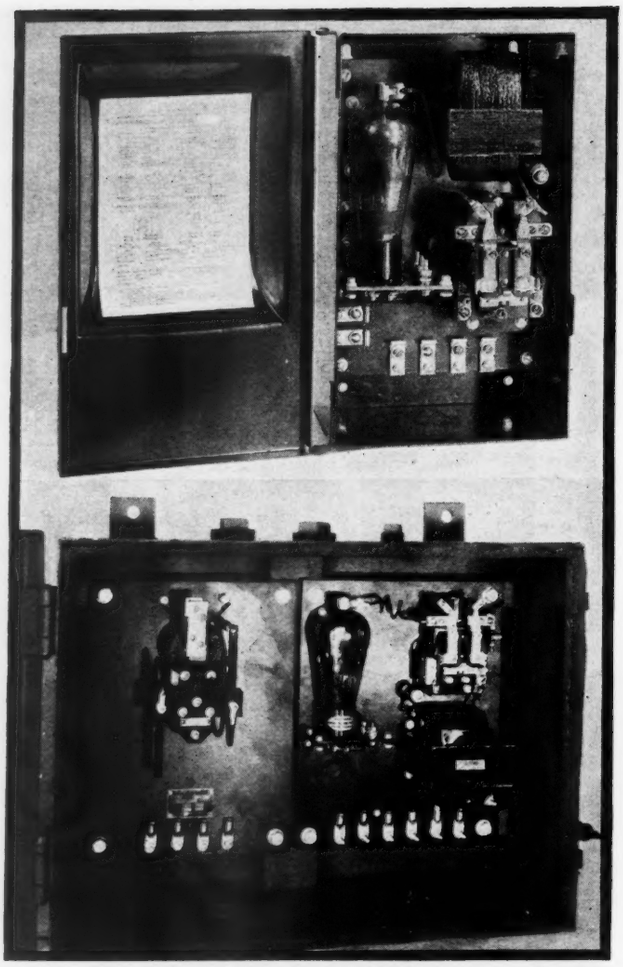


Figure 2. An electron tube control designed for light-duty, indoor service should not be asked to stand rough usage or severe exposure. Figure 3. For severe operating conditions, rugged design and welded construction are necessary

In servicing light-sensitive equipment, attention must be directed to the lenses and windows which transmit the light. If they become clouded by moisture or dust, the amount of light transmitted will be decreased.

It is good policy to have at least one spare tube of each type in use, for immediate replacements. Also, one of the simplest tests to determine whether a tube is defective is to replace it by a good, spare tube. Until industrial electronic devices come into wider general use, it will not pay to provide elaborate tube-testing sets.

In the event of actual failure, a competent electrician with the aid of the circuit diagram, a continuity test device, a voltmeter, and a little ingenuity, can usually discover and correct the trouble unless the equipment is quite complicated; in that case it may be better to call upon a service representative of the manufacturer.

When shooting trouble in electronic equipment, assuming that the symptoms give no clues to the cause, the first step is to make sure of the power supply. Changes in the plant load may have reduced the voltage. Next, leads and connections from the electronic device to the other equipment may have become loosened, a wire may be grounded, or some other common disorder outside the device itself may have occurred.

Next, the tubes should be replaced, if spares are available. This is a quick and simple test for defective tubes. A continuity test should be made to insure that connections, resistors, capacitors, transformers, and reactors are not open-circuited, shorted, or grounded.

Lastly, a voltmeter should be used when possible to make certain that specified voltages are actually obtained. In making this test it must be remembered that electronic-tube equipment operates at relatively low power levels; therefore, a meter requiring a considerable amount of power cannot be used indiscriminately.

The following excerpt from an instruction book gives a good idea of what tests are required:

If the light relay does not function properly when installed or after a period of service, the trouble may be found as follows:

The circuit should be checked carefully.

(a) The light relay may be installed incorrectly.

(b) If, when the phototube is dark, the Grid-Glow tube will not glow and pass current:
1. There may be no supply voltage.
2. The transformer, load resistor, or relay may be damaged or open circuited.
3. The Grid-Glow tube may have failed.

(c) If, when the phototube is illuminated with the recommended amount of light, the glow tube cannot be stopped from glowing and passing current:
1. The phototube may have declined in sensitivity.
2. The Grid-Glow tube may have failed. (This kind of glow tube failure is unlikely).
3. The supply voltage may be excessively high.

(d) If, upon progressively illuminating the phototube, the Grid-Glow tube glows, stops, and then again glows, (shows transition points):
1. The Grid-Glow tube is at fault.

(e) If the telephone-type relay does not operate when the Grid-Glow tube glows:
1. The supply voltage may be too low.
2. The relay coil or the condenser across the coil may be short circuited.
3. The load resistor may be out of adjustment.
4. The telephone-type relay may be out of adjustment.

(f) If the telephone-type relay chatters:
1. The condenser across the relay coil may be open circuited.
2. The relay may be out of adjustment.

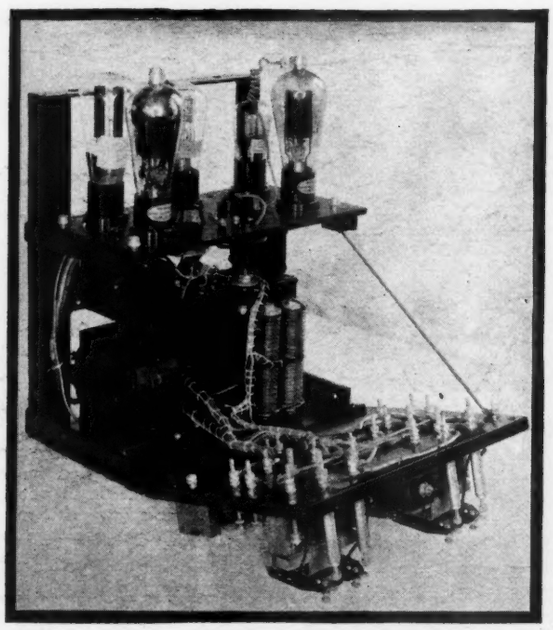


Figure 4. This outfit controls the action of a register cutter. The hinged panel construction makes it easier to give such maintenance attention as is required

If trouble described under *(e)* 3, 4, or *(f)* 2 is experienced, one lead to the photo tube amplifier unit, terminal *A* or *F*, should be removed and a d.c. milliammeter placed in the circuit. With 110 volts on the primary and the Grid-Glow tube glowing there should be 10 milliamp. flowing in the circuit. If the current differs from this value adjust the load resistor until it is obtained.

The telephone-type relay should pick up on approximately 6 milliamp. If it does not operate at this value of current it may be adjusted by changing the air gap. To do this, loosen the locknut and screw on the end of the relay; then turn the hexagon-headed screw to the right to make the relay pick up on less current, or to the left to make it pick up on more current. The locknut and screw should be carefully tightened again.

If it is found impossible to make the light relay work, it should be returned to the factory for repairs.

Manufacturers of tubes usually make some statement in their literature as to the expected life, and this rating should be taken into consideration in determining a test schedule. No more than routine maintenance tests need be made on tubes until approximately three-fourths of their expected life has expired. They should then be watched somewhat more carefully and replaced as soon as a new tube shows very evident signs of improving the operation of the equipment. It is often advisable to replace a tube after expiration of its expected life, even though it appears to be operating satisfactorily.

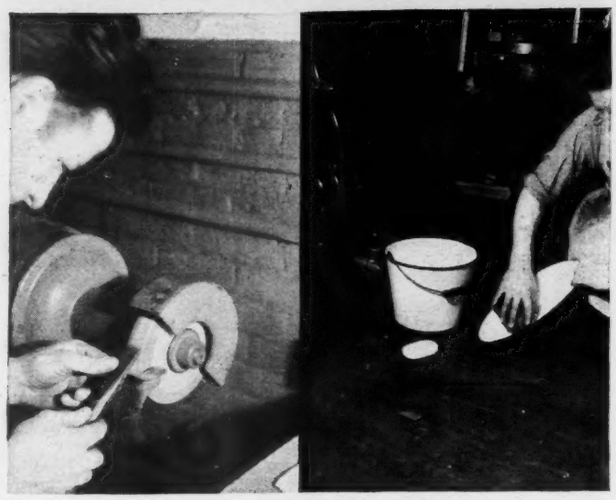
Aside from the tubes, electronic devices have a relatively indefinite life if well designed. Such parts as transformers, capacitors, resistors, and reactors will give many years of maintenance-free life if operated within their ratings. The life of the tube depends upon its design and intended duty. Under continuous service, the life of the average industrial tube varies from approximately six months to a few years. Some equipments have been in practically continuous operation for five years without requiring tube replacements. In equipments which are used only occasionally, tube life will be indefinite and replacements may never be required.

When working with the circuit of electronic-tube devices, the power should always be cut off as a safety precaution. The tubes should be removed carefully by grasping them at the base, since removal by the glass may introduce strains in the seals which will cause leakage. Such care will eliminate breakage caused by careless handling or inadvertent slipping of a screwdriver or a pair of pliers. Unless the part being serviced is readily reached, the equipment should be removed from the cabinet to facilitate repairs.

In all electronic equipment, the general principle of operation depends upon a stream of electrons, ions, or both. Since this stream has no inertia in the general sense of the word, it can be started and stopped or controlled in magnitude with very little energy and at very high speeds; not subject to wear, it does not fatigue or become damaged by an infinite number of operations. Hence, in practically all installations the mechanical moving parts, such as contactors or solenoids, are what demand the maintenance, rather than the strictly electronic parts.

Since the tube is the heart of the electronic device, it should be of the highest quality obtainable. Many times the difference in price between a cheap tube and a real industrial tube can easily be spent in shooting trouble and in interruption to operations, the latter item likely to be especially costly.

A Tool Called Light



James M. Ketch

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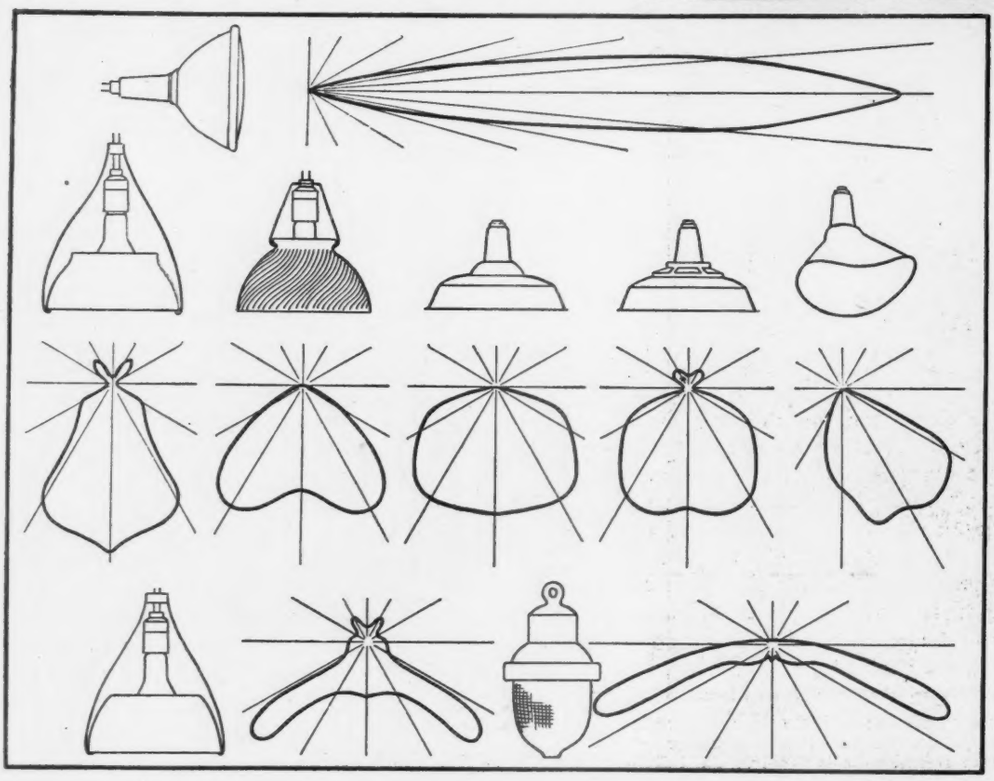
MUCH information is available on the subject of artificial light and its many applications in industry; extensive tables are available that show how problems in illumination design are solved. Such a wealth of information indicates a healthy interest in illumination, but it may lead one to feel that lighting is very technical and difficult to understand. This discussion will simplify as far as possible the characteristics of artificial illumination and draw some simple analogies between it and other tools used in industrial plants.



1. For every tool a handle—for every lamp a reflector

•

2. Dull tools must be sharpened — dirty lamps and reflectors cleaned

•

3. For rough, hard work, the cold chisel —and its counterpart, the rough-service lamp (at the left)

•

4. There is a tool for every job—and a lamp suited to every lighting need

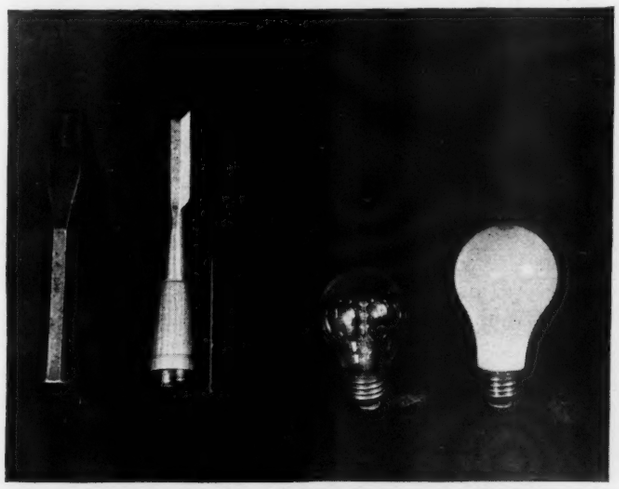
•

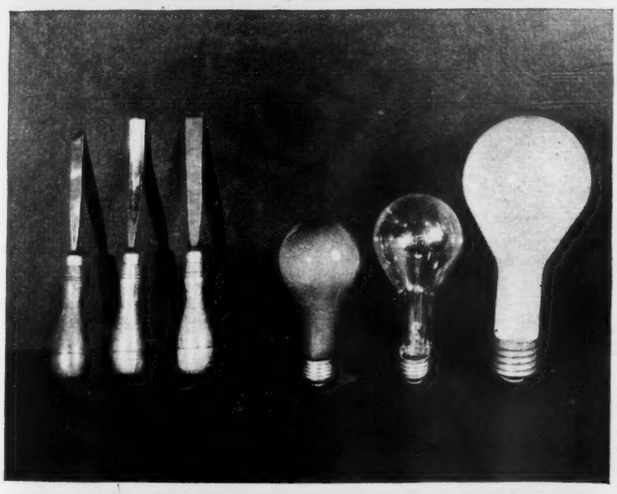
5. Lamps, like tools, may be had in many sizes. It is not difficult to choose the proper one for the job

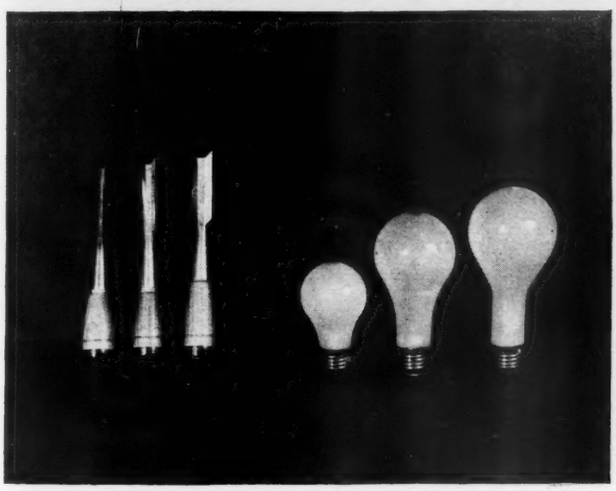
•

LEFT
Getting the light distribution needed is a matter of using the proper reflector.

The purpose of any tool, the reason why it is purchased, maintained, and replaced when obsolete, is to aid workmen to fabricate and assemble materials into finished products. Every tool costs money to buy, labor to maintain, power to operate, and dollars to replace. It is the duty of the production manager to balance the cost of finished products with and without the use of these aids. Artificial light is not employed as a grinder of surfaces, a cutter of shapes, or a driller of holes; it is, nevertheless, just as necessary to their production as the machines that do the work. Like other tools, it can be productive and worth the investment, or non-productive, and hardly worthy of being classed as a tool.







Every employer of craftsmen knows that he is an employer of eyesight, and that the workmen's ability to see is just as necessary as the good tools put into their hands. Light, then, is not just a mere necessity; it is a tool that must be paid for, maintained, and scrapped when the equipment producing it is obsolete or inadequate.

Tools Must be Sharp

When one picks up a tool, one first tests its edge for sharpness because sharpness is synonymous with effectiveness, efficiency—even safety. If the tool is not sharp, the craftsman makes use of the abrasive wheel and oil stone before beginning work. However, that sharp edge is to be used on the surface of the work and not on his fingers.

In the light tool rack, the parallel of sharpness is called brightness. The filament of an incandescent lamp is bright—exceedingly bright. The manufacturer has intentionally made it so, because brightness in a filament is indicative of the total amount of light. Great brightness for a given expenditure of wattage is a measure of efficiency and the potential ability to produce working illumination.

The sharp brightness of the exposed filament, however, is no more intended to be applied to the workmen's eyes than are the sharp edges of the cutting tool to their fingers. If a workman is continually cutting his fingers on the sharp tools, either he is a bungliing workman or the sharp edge is not properly protected. In either case, it indicates inefficiency of operation. In like manner, if too much light reaches the workman's eyes and he is subjected to glare, it indicates inefficiency. The light that makes glare, causing discomfort and reducing the ability to see, is light that should be on the work.

Light on the work may be considered as *positive* because it aids the workman; light in the eyes, of sufficient brightness to cause discomfort or glare is *negative* since it reduces his ability to see his work.

Size Must Be Right

Few workmen would go to the tool rack and select a ½-in. chisel for a job requiring a 2-in. chisel. The well-equipped plant has tools of the proper size for each job. Work can be done with tools of the wrong size, but not efficiently.

In the light tool rack, there is a wide range of tools, varying from the smallest grain-of-wheat lamp to the largest lamp, which consumes 50,000 watts. The sizes that find the greatest use in industrial plants range from 200 to 1,000 watts.

In any lighting job several factors are usually beyond control: the ceiling height determines the widest spacing for the lighting units that will give fairly uniform illumination; the bay dimensions determine the actual spacing to be used, assuming that a uniform arrangement is desired; the visual task to be performed determines the intensity to be used.

These limitations leave little leeway in selecting the lamp size that will produce the required foot-candle intensity. Usually the lamp size is the last item to be

calculated, and an adequate range is therefore desirable.

Shape Is Important

The shape of a cutting edge is all important, and each of the differently shaped cutting edges has a job for which it is best adapted.

Quality, or color of light, is the corresponding characteristic in the rack of lighting tools. Clear, daylight, flametint, and color lamps all have jobs to do. The clear lamps which produce unmodified light are the ones usually used.

There are three well-defined grades of artificial daylight—that obtained by the use of daylight lamps, noon sunlight, and north skylight. That obtained from daylight lamps is not intended to duplicate the quality of daylight, but rather to produce an illumination effect that looks more like average daylight than that produced by clear lamps. This grade of illumination is not recommended for close color matching. The noon sunlight and north skylight qualities are produced by plates and globes used with standard clear lamps. Depending upon the density and color composition of the plates or globe filter, any grade between noon sunlight and north skylight can be closely approximated.

Sharpness, Efficiency, and Ruggedness

There are two kinds of flat chisels—the wood chisel, which sacrifices the maximum of ruggedness for sharpness, and the cold chisel, that sacrifices some sharpness for ruggedness. Each in its own way is most efficient for its duty.

Fifty-watt lamps are made the same way. The standard 50-watt Mazda lamp is more efficient as a light producer, but less rugged than the rough-service lamp which sacrifices some light to obtain the ruggedness necessary for its purpose. Each in its way is the most efficient for the intended service.

Handles for Cutting Edges

One could saw a board with a saw that had no handle, but the operation would not be efficient or safe. An effective handle fitted to the cutting edge is necessary. In lighting that device is the reflector, which makes the illumination efficient by directing the light to the work, and safe for the eyes.

The light from a bare lamp should be considered a raw product, consisting of light emitted in all directions. Without a reflector a small part of this light will go in the direction desired, but a large part will go where it does no good and is not wanted.

Light can easily be fabricated into almost any shape of candlepower distribution desired. It can be reflected regularly from a mirror, or diffusely from a flat, white-painted surface. Any degree of reflection or diffusion between those limits is possible. By means of refracting prisms its direction can be changed; its color can be changed by employing colored glasses. There is little need to use the raw light from bare lamps when such control is possible. The varying degrees of control and diffusion in direct lighting equipment alone are shown in the accompanying chart.

Maintenance

When the cutting edge of a tool becomes dull, the abrasive wheel and oil stone quickly renew it. The cure for dull tools is so simple, and their disadvantages are so obvious, that few workmen are content with any but the sharpest.

Through use and the unavoidable collection of dust and dirt, the lighting tools lose effectiveness. Dirt is a great consumer of light. Undoubtedly many lighting systems are wasting half of their wattage because of lack of maintenance.

Maintenance can be facilitated by anticipating the problem of maintenance when designing the system, and mounting the units so they will be accessible. Reflectors over a craneway, for example, should be accessible from the crane rail, or mounted on safety lowering switches. In lower ceiling areas separable reflectors or mounting methods can be used that make it simple to clean the reflecting parts and lamps on the floor.

A careful analysis of cleaning costs compared with the cost of current that is not creating light will usually determine the frequency with which reflectors should be cleaned. The floors of most factories are cleaned every day. Perhaps the lighting tools should be thoroughly cleaned at least one-thirtieth or one-sixtieth as often—once every month or every two months.

An illuminant is another tool, and should be treated as such; otherwise it becomes just another accepted necessity, and an expenditure from which little return is to be expected.

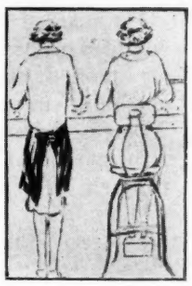
Gardens to Call Their Own

GARDENS sponsored by the Otis Elevator Company for employees of its Yonkers, N. Y., plant were so successful last year that the project is now being undertaken on twice as large a scale. For each dollar invested by the company in 1932, there was a return to the men of $6.30 in food. The value of the food from each garden averaged $33. The effect on company morale has been noticeable.

This year the company is making 3½ acres of ground available. There are three plots. Each worker is assigned to the plot nearest his home.

Details have been carefully worked out. Plots assigned vary in size with the number of dependents. An employee with up to four dependents may have plot 19x51 feet; a man with five is allowed 19x69 feet; and a man with six or more is given a piece of ground measuring 19x80 feet. Each gardener is given a planting diagram and must plant a certain number of standardized items, selected of course with the idea of supplying a well-rounded diet. Gardens are therefore uniform and attractive in appearance. Eight per cent of each plot, however, is left for optional planting. The company ploughs and harrows the ground, fertilizes it, provides tools, supplies seeds, onion sets, tomato and cabbage plants. The employees do the rest under the supervision of a technical adviser.

They Sit or Stand



and are better operators for the change in posture

William R. Mullee
American Hard Rubber Company
Butler, N. J.

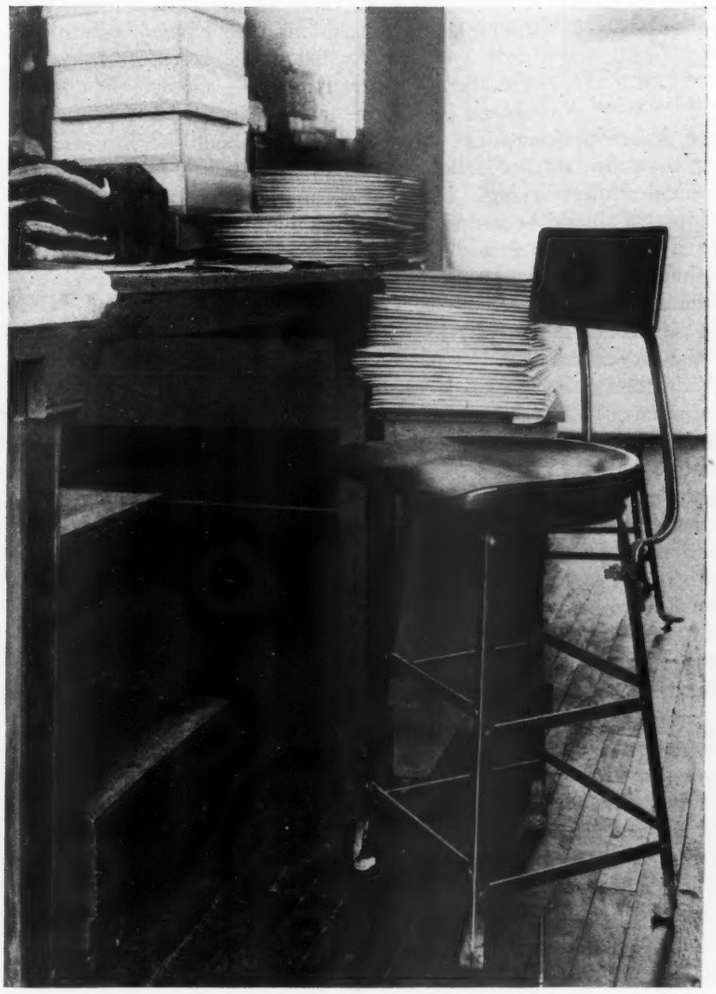
Constant standing is unnecessarily tiring. Continuous sitting is no better. Correct seating and a nice balance between sitting and standing have a direct bearing upon workers' health and output

WHILE making time and motion studies in one of our packing departments, preparatory to a wage-payment installation, our time-study engineers reported an abnormal difference between studies taken in the morning and those in the late afternoon. The operators were noticeably fatigued in the afternoon; it was the consensus that the fatigue was due to improper seating. Either seating had to be improved or an extra allowance made in the standard to compensate for the loss.

In approaching the problem of reducing fatigue, one of the engineers made a study of all available literature. The most helpful data were obtained from Bulletin No. 141, New York State Department of Labor, and from an article by Elizabeth S. Johnson in "Labor and Industry," August 1928, Pennsylvania Department of Labor.

Constant sitting as well as constant standing is fatiguing. We decided that the "sitting-standing" arrangement offered the best solution, since it permits the operator to vary his position and thereby relax his muscles. With this arrangement, the position of the elbow and forearm is the same whether sitting or standing. Slipping combs into envelopes and attaching to display cards is done while seated. The wrapping can best be done standing.

The first step was to decide on the table height while standing. The seated height can be arranged to suit by varying the chair height. Table heights of from 34 to 37 inches are recommended. After considerable experimenting with a group of operators, a table height of 36 inches was adopted.



It cost $2.05 to convert this stool into a posture chair

In order to keep the cost of installation down to the minimum, we investigated the possibility of rebuilding chairs on hand to dimensions laid down by the above-mentioned authorities. It was evident that they had done considerable research work from physical and medical viewpoints. We found that our round seat,

steel stools, with adjustable back rests, could be converted into posture chairs by adding a properly shaped seat, adjusting the back rest and the legs, and providing a foot rest. Saddle-shaped chair seats were purchased from a manufacturer, and the chairs rebuilt exactly to specifications. Chair seats cost $1.25 each, to which was added 80 cents for attaching the seat and adjusting the legs, making $2.05 the total cost of rebuilding each chair. The adjustment to the legs consisted of heating with a welding torch and curling over the bottom ends until the correct height was reached. Several heights were provided for different operators. The new seats were fastened on top of the round wood seats with wood screws.

Seat is too low

The correct working height for different kinds of operations depends upon whether the work is done at the bench or at the machine. On machine operations, the elbow should be slightly below the work. On bench operations, the elbow should be at same level or above the work. When packing large articles, the table should be lower than for smaller articles so that the forearm is horizontal while working. If the work motions permit, the forearm should be supported by the table or an arm rest. The shoulders should not be raised while working but should assume a natural relaxed position. Seating problems are considered so important by a few large firms that a competent physician prescribes the chair to suit the individual.

With the table height decided on, clearance of six inches was found necessary to accommodate operators' thighs between chair and underside of table. This decided the chair height, with slight variation for certain individuals.

Tall girl, ordinary chair

When an army recruiting officer asked Lincoln how long a man's legs should be to qualify for the Union Army, he said they ought to be at least long enough to reach the ground. The increased chair height, due to the sitting-standing arrangement, gave us a similar problem, so we provided individual foot rests, varying in height to suit individual leg length. The feet should rest squarely on the foot rest. A cleat at the lower edge helps to brace the heels.

The packing department was on piecework based on the usual form of time study. No attempt had been made to analyze from a motion-study viewpoint; hence the rates were inflated by the fatigue condition. The new seating arrangement was installed the same week that the department changed over to the new wage-payment method. During the three weeks prior to changing over, a "test period" was conducted measuring with the new standards while continuing payment on the old piecework basis.

The results are interesting:

	Before Change			*After Change*					
Week	1	2	3	1	2	3	4	5	6
Dept. Unit Rating	79	78	83	104	116	123	123	123	125

No foot or back rest

A unit is a work minute. The unit rating is the number of units produced per 100 minutes. Department unit rating is the average of all the individual operators' unit ratings for the week.

The marked improvement shown was due to remedying defects observed during motion study — training poorer operators in better motion practice, arranging work place to suit motion principles, smoother flow of work through better planning, and reduction of fatigue by improved seating. The total reduction in labor cost was 30 per cent, of which 5 to 10 per cent may be credited to improved seating.

Executives coming in contact with this department have commented on the improved morale of the operators. From our experience here we therefore recommend that the motion analyst include a study of seating conditions as an important part of operation analysis.

Sketches by courtesy of the Department of Labor, State of New York.

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Trucks Come—Chute Goes

F. C. Fleming, Assistant, Administrative Department
Jewel Tea Company, Inc., Barrington, Ill.

WHEN OUR plant was designed, a method—which looked highly desirable to everybody—was devised as a means of cutting handling expense. There are three coffee packing lines, and the layout provided three gravity roll conveyors running from the three sealers to a chute leading to the shipping floor below.

The theory was that the cases would slide down automatically after they left the sealers. Actually, since the three packing lines could not be synchronized without considerable loss of time, the filled cases had a disconcerting habit of arriving simultaneously at the mouth of the chute. A man had to be kept at the ends of the case sealers to keep the cases from jamming up the chute, another—who was not particularly busy—at the head of the lines making up cases for the sealers, two more at the bottom of the chute to pick the orders for shipment.

After a few months, it was decided that here was one labor-saving device that caused added labor. So the chute was removed, and the whole handling method shifted over. Now a floor truck is spotted at the end of each sealing line. The man who makes up the cases at the head of the three sealing lines makes up a few ahead of requirements, walks to the end of the lines and removes the filled cases from the gravity rolls to the floor trucks. When a truck is loaded, he pushes it over to finished stock storage a few feet away. Here another man picks orders onto other floor trucks, stencils the cases, moves the trucks to the freight elevator. The elevator man has to be on the job anyhow. Most of his loads are up-bound, so these down-bound trucks of coffee hardly increase his work.

It looks to a casual visitor in this highly conveyorized plant as though this operation should be more costly than if it were entirely mechanical, but the cost figures show that it halved the expense of the original method.

Maintenance Cost Control

III—Control Methods

W. C. Zinck

Head of Standards, North & Judd Manufacturing Company
New Britain, Conn.

THERE ARE several methods in force in industry today to control maintenance costs, each method having a different fundamental approach to management to obtain permission to do the maintenance work —for maintenance is always an expense item. Aside from that fundamental difference, however, every system embodies the same good principles of management if it exercises successful control in operation. These principles are:[5]

1. Development of proper organization.
2. Discrimination as to size of organization.
3. Definite period of inspection of equipment.
4. Development of methods for careful analysis of maintenance costs.
5. Development of standards of performance for maintenance division.
6. Development of proper plan to rate the division as to its effectiveness in meeting predetermined standards of performance.

(1) and (2) The problem of the proper organization and its size is no different for maintenance than for productive work. Each factory has its own routine repairs and a general scope of work to do effectively. A capable maintenance head develops an efficient organization through an analysis of what is to be done and the abilities of those available to do it, and a proper delegation of duties with adequate instructions.

(3) The periods of inspection of equipment vary with the operating equipment of each factory of each industry. The production urgency of each piece of equipment is the vital factor that must be considered. Other than that, the old proverb of a stitch in time prevails. Certain equipment must not fail between the routine shutdowns for general repairs, while other factory equipment may fail without undue total loss and thus not warrant the expense of constant maintenance inspection.

(4) The methods necessary to record for careful analysis the cost of all maintenance work vary with the size of the factory and the type of the work done. A simple written order suffices in a small plant where personal contact between the maintenance division and the cost department prevails, while a complicated system of originals, duplicates, and triplicates is necessary to assure proper checking, recording, and accounting in a large plant. However, the essentials are the same; the hours of labor and the corresponding hourly rates, the materials used and the prices, and the equipment worked upon must be given, checked, and recorded for comparative analysis.

(5) The development of the standards of performance for the maintenance division is the important phase in the origination of any control system, because the standards, upon establishment, are the permission of management to spend a predetermined amount of money, and serve as the yardstick for measuring the money actually spent. As previously inferred, the manner of setting the standards of performance is the distinguishing characteristic between control systems. Each plant has a certain amount of maintenance work to be done; if done, it must be paid for. Hence, by combining past experience and judgment, or by a scientific analysis, it is possible to determine approximately what should be paid —or to set maintenance standards.

The form in which past experience has been received by management determines, usually, the method of setting standards. If management thinks of plant costs in terms of a unit of output, the maintenance standards would be set by a ratio to a productive unit. If management operates the plant in general on a budget, maintenance expenses (standards) would be budgeted from period to period. Or if management had firm belief in the worth of accurate estimates or time studies on individual jobs, the maintenance standards would be time allowances for each specific job done. Thus, in general, the methods of determining maintenance standards may be classified as follows:

a. By a ratio to a productive factor.
b. By a budget to cover a set amount of work.
c. By time allowances on individual jobs, with a check on the total expenditure.

It might be said that the time-allowance method is but a refinement of the ratio or budget method, inasmuch as the total expenditure must be checked even though detailed costs are controlled closely. However, there is a distinction—a budget or ratio set-up does not require individual job allowances, and only the total cost is checked, which is a different method of attack from checking detailed costs closely and then keeping the total cost somewhere in line with other operating factors.

The effectiveness of the three methods of control given

[5]"Organization," R. R. Rees, Plant Engineer, Packard Motor Car Company, Detroit, *Industrial Engineering*, March, 1930 (pages 165-7).

above are in the order given, the ratio method the least and the time-allowance method the most effective. The total effectiveness is considered, or the effectiveness in keeping the entire plant equipment in good repair over a period of time, and not effectiveness in keeping expenditures within the allowances. The ratio method, in principle, says this: "There are so many productive units, therefore so much can be spent," and implies, "Do the best that can be done with what is to be spent." It does not of itself take into consideration what should be done, which is often widely different from what can be done within the ratio. The budget method, in principle, has the work that should be done discussed beforehand, and then decides what is to be done—which will give better plant condition on the whole than by spending an arbitrarily determined amount of money. The time-allowance method, in principle, assures that each job will be done at the lowest cost possible, so that with the ratio or budget check on the total cost, the money actually spent will do more maintenance work per dollar. However, the effectiveness of any method may be so greatly improved by a well-adapted incentive for the head of the maintenance division that the deficiency inherent in the method may be overcome.

(6) The plan to rate the maintenance division as to its effectiveness in meeting predetermined standards of performance depends upon the method of control used. The current check for the ratio or budget method is simply a comparison of the money actually spent during a specified period with the allowance for that period. The current checks for the time-allowance method are percentage of total hours on estimated jobs, time actually taken against time allowed, and money spent against allowance for the same period.

The long-time check must, of course, be the comparison of the findings of complete surveys of the entire plant equipment at definite intervals. This is a check on the total effectiveness of the method, and includes such items as total production delays and expense, plant appearance and its effect on employee morale, total repair costs in the light of the worth of the equipment and the advisability of replacement, accidents and safety, and depreciation costs.

The three methods of controlling maintenance costs will be discussed in detail in sections to come. Each method will be considered in the light of its basic principle, and actual applications described. However, like any other factory method developed from past experience and judgment, a plan for a specific plant may combine features from all of the three methods.

Dual-Voltage Connections for Induction Motors

Three-phase star series and parallel connections, twenty to twenty-four poles

A. C. Roe

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Westinghouse Electric & Manufacturing Company
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THIS ARTICLE will present the three-phase, star, dual-voltage, schematic-line-type diagrams for the 20-, 22-, and 24-pole range of connections. In addition, information will be given on the procedure to be followed in checking a winding, or retagging the external leads of a three-phase, star, dual-voltage, motor winding when all or a part of the tags are missing from the leads.

For connecting the leads of such windings to the line, Table III in the July, 1932, issue of *Maintenance Engineering* should be used.

For the 20-pole range there are four possible dual-voltage connections: (1) series and two-parallel star, Figure 1; (2) two-parallel and four-parallel star, Figure 2; (3) five-parallel and ten-parallel star, Figure 3; (4) ten-parallel and twenty-parallel star, Figure 4. These diagrams can also be used as single-voltage connections, as described in previous articles, and will cover six possible connections, making a total of ten connecting diagrams that can be equalized, if desired.

With 22 poles there are only two possible dual-voltage, three-phase, star connections: (1) series and two-parallel star, Figure 5; (2) eleven-parallel and 22-parallel star, Figure 6. Or, four single-voltage connections can be made, giving a total of six possible connections with these diagrams.

[Figures 1 to 7 only are reproduced in this issue. The balance (8 to 12) will be published in September.—Ed.]

The 24-pole range offers the greatest number of possible three-phase, star, dual-voltage connections of any pole range in this series, since there are six possible connections: (1) series and two-parallel star, Figure 7; (2) two-parallel and four-parallel star, Figure 8; (3) three-parallel and six-parallel star, Figure 9; (4) four-parallel and eight-parallel star, Figure 10; (5) six-parallel and twelve-parallel star, Figure 11; (6) twelve-parallel and 24-parallel star, Figure 12. Also, eight single-voltage

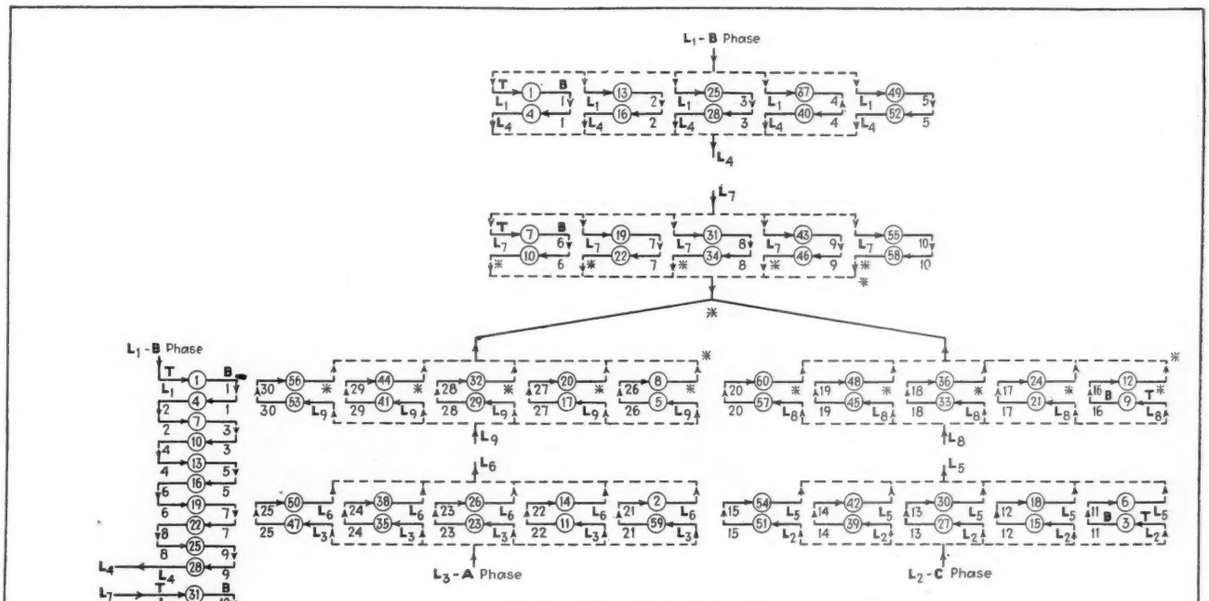


Figure 3. Three-phase, 20-pole, five- and ten-parallel star

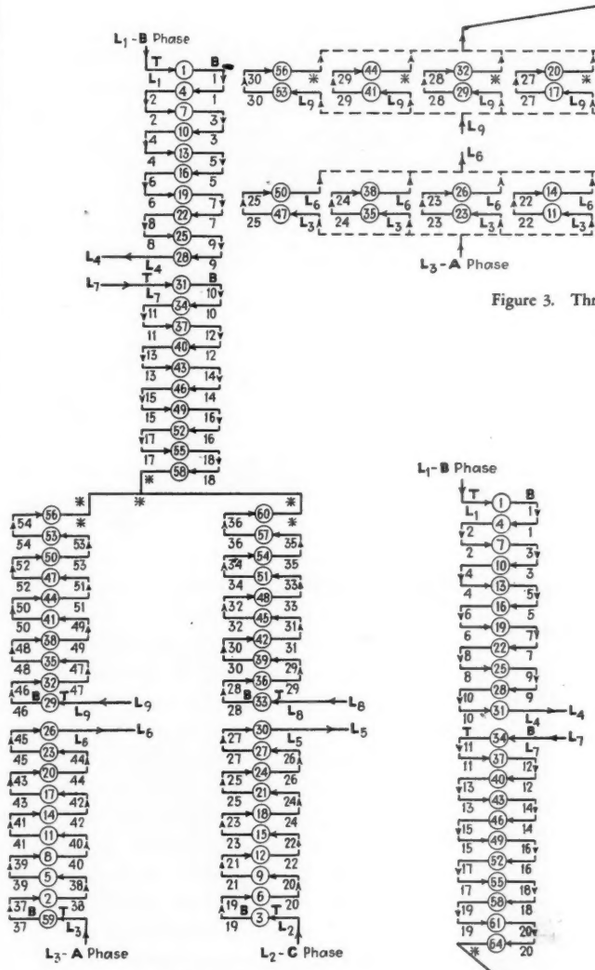


Figure 1. Three-phase, 20-pole, series and two-parallel star

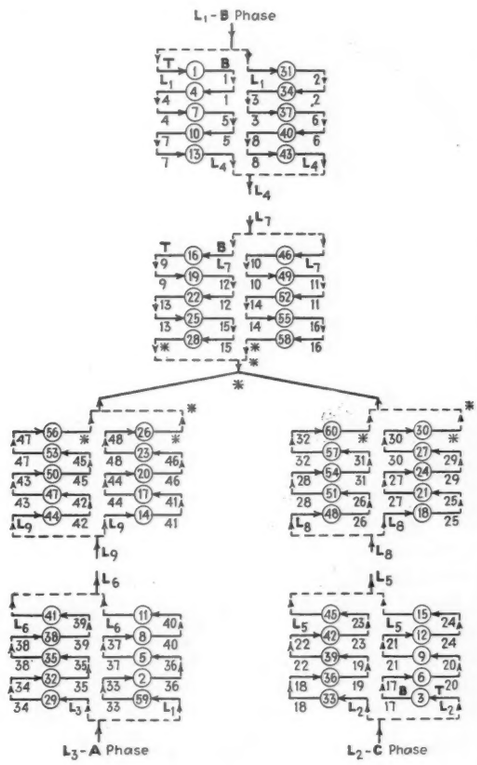


Figure 2. Three-phase, 20-pole, two- and four-parallel star

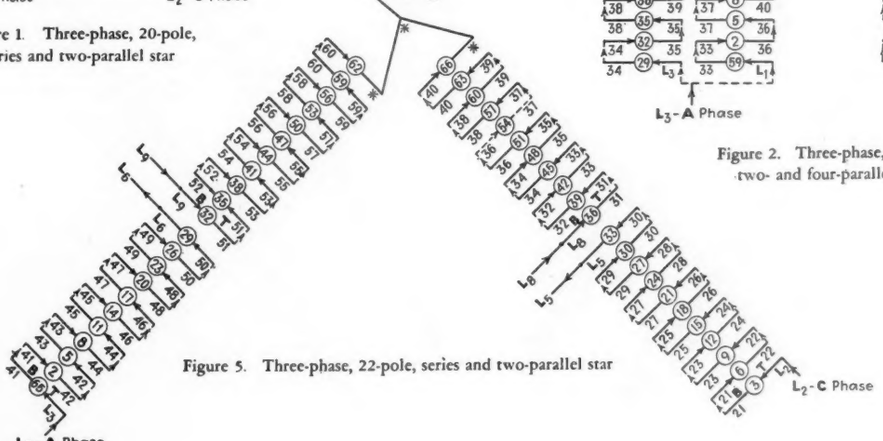


Figure 5. Three-phase, 22-pole, series and two-parallel star

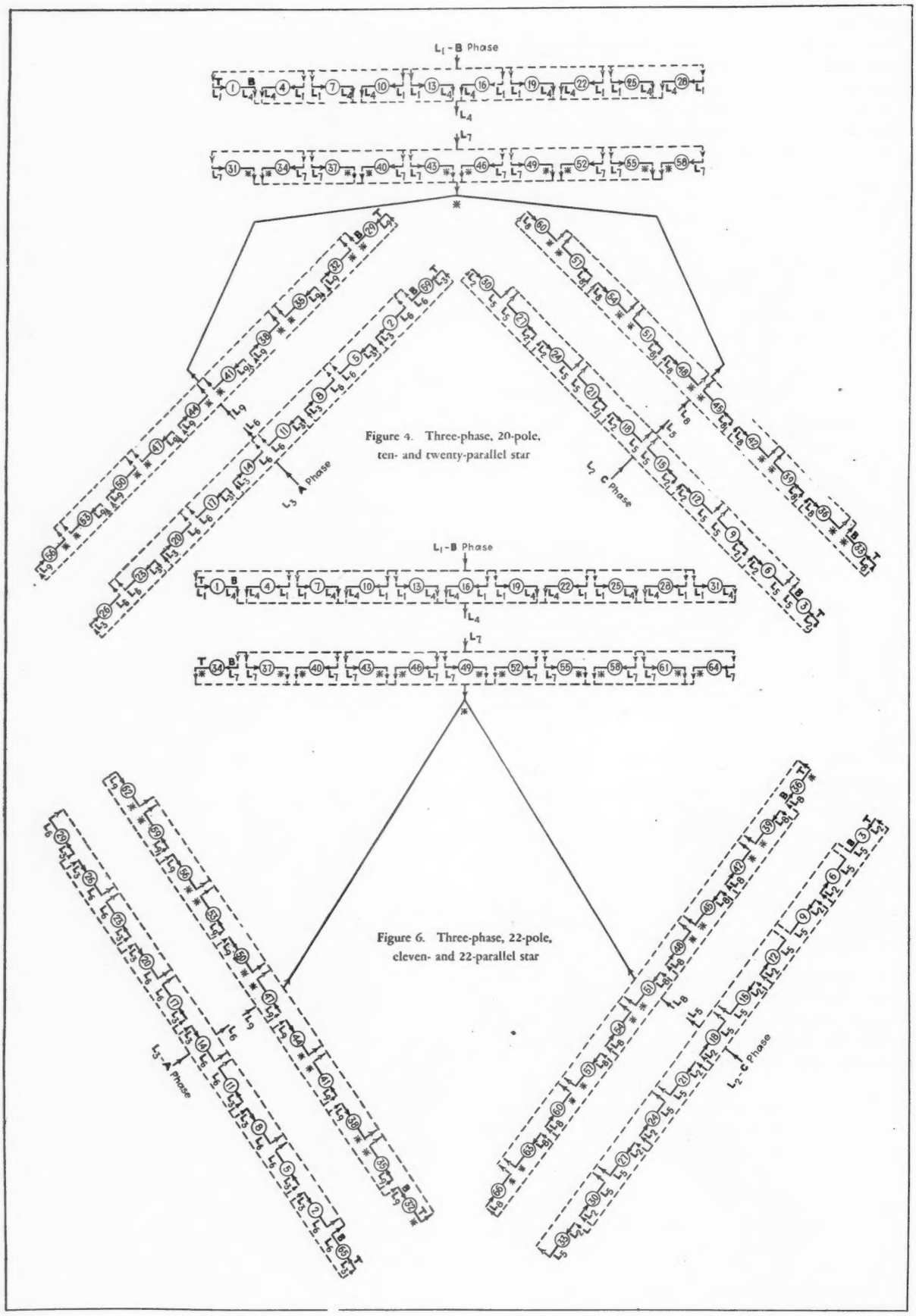


Figure 4. Three-phase, 20-pole, ten- and twenty-parallel star

Figure 6. Three-phase, 22-pole, eleven- and 22-parallel star

connections can be had, making available fourteen different types of connecting diagrams with the 24-pole range, in addition to the equalizer connections possible.

Checking Dual-Voltage Connections

The winding of any dual-voltage motor that has been connected by the use of a diagram can be checked for correctness by two methods, for two-phase windings (June, page 242). The steel-ball test can also be used with good results; in fact it is well to practice this test. By reversing coils in a group and making other changes, information can be obtained as to the effect of various defects on the action of the ball.

The procedure to be followed in retagging a three-phase star type of dual-voltage winding from which all or part of the lead tags have been lost is somewhat similar to that outlined in the preceding article for two-phase windings. The number of poles, type of connection, as series and two-parallel, two-parallel and four-parallel, and so on, must be determined. Then the nine leads must be divided into four groups.

Sectionalizing the nine leads into four groups means that three of the groups will have two leads each, which accounts for six leads; the fourth group will have three leads, and by referring to Figure 1, or any star, dual-voltage connection, it will be seen that the three-lead group is the one that has a section of each phase connected in it and also contains the permanent internal star connection.

The leads of the three groups of two leads each should be marked temporarily, *A-A, B-B, C-C,* and so on; each lead of the three-lead group should be marked *D-D-D.*

Phasing the four sections into the proper three-phase star arrangement can be started by using the three-lead group as a base. For example, using Figure 1 as a guide, take any one *D* lead, tag it *L7,* follow this lead to its group connection, and mark the group *31.* Then, by means of the test light, check the direction in which group *31* must be followed through in order to come out on the jumper. Mark this direction with a chalk arrow on the core, and follow through the rest of the section to the star connection, marking each group with a number and an arrow.

After checking one section, the polarity and group numbering rotation have been established; it is now a simple matter to number all of the remaining pole-phase groups and apply direction and polarity arrows, using a diagram such as Figure 1 for a guide. Then locate group *33* and check it to determine whether it has the proper direction and if the three leads of the group are connected to it in the proper manner. If so, tag this lead *L8.* Likewise, locate group *29* and check it for polarity and location of the remaining lead of the three-lead group. If correct, tag this lead *L9.* Now, one-third of the winding has been tagged.

To locate the second section of the B phase, refer to the diagram, Figure 1 in this case, and find that lead *L1* is located at the top of group *1.* Find group *1;* then check it for polarity and location of lead. If correct, mark the lead from group *1, L1,* and the remaining lead of the same group *L4,* as shown.

Next, locate group *3* and check it for polarity and lead connection. If found to be correct, mark its lead *L2;* the other lead of this group becomes *L5.* The last section is located in the same manner. By finding group *59* and applying the check for polarity and lead connection, leads *L3* and *L6* can be marked.

The method outlined above of checking through one section of a phase, marking each group as it is located with a number and arrow, provides a means of marking all the rest of the groups and gives one a key to the general type of connection diagram that was used, so that a similar one can be selected or drawn up to assist in the complete retagging operation.

A series connection was used in both the two- and three-phase examples as it simplified the discussion and helped to bring out more clearly the methods of procedure in retagging a winding.

A parallel connection, as the two-parallel and four-parallel star diagram in Figure 2, presents a different problem since one group lead must be selected and temporary numbers applied to each group, as *1-2-3,* etc. The same procedure is followed for each parallel leg in the section. The location of these groups with respect to each other will furnish the key to the proper diagram to use or sketch in. As it is a simple matter to use the same arrangement to fill in the first section of the same phases, renumber the groups with numbers and polarity marks, and proceed to locate the remaining leads.

Thus, the problem of retagging resolves itself into a matter of applying known rules in order to select or prepare the proper diagram for checking the winding under consideration for proper lead location.

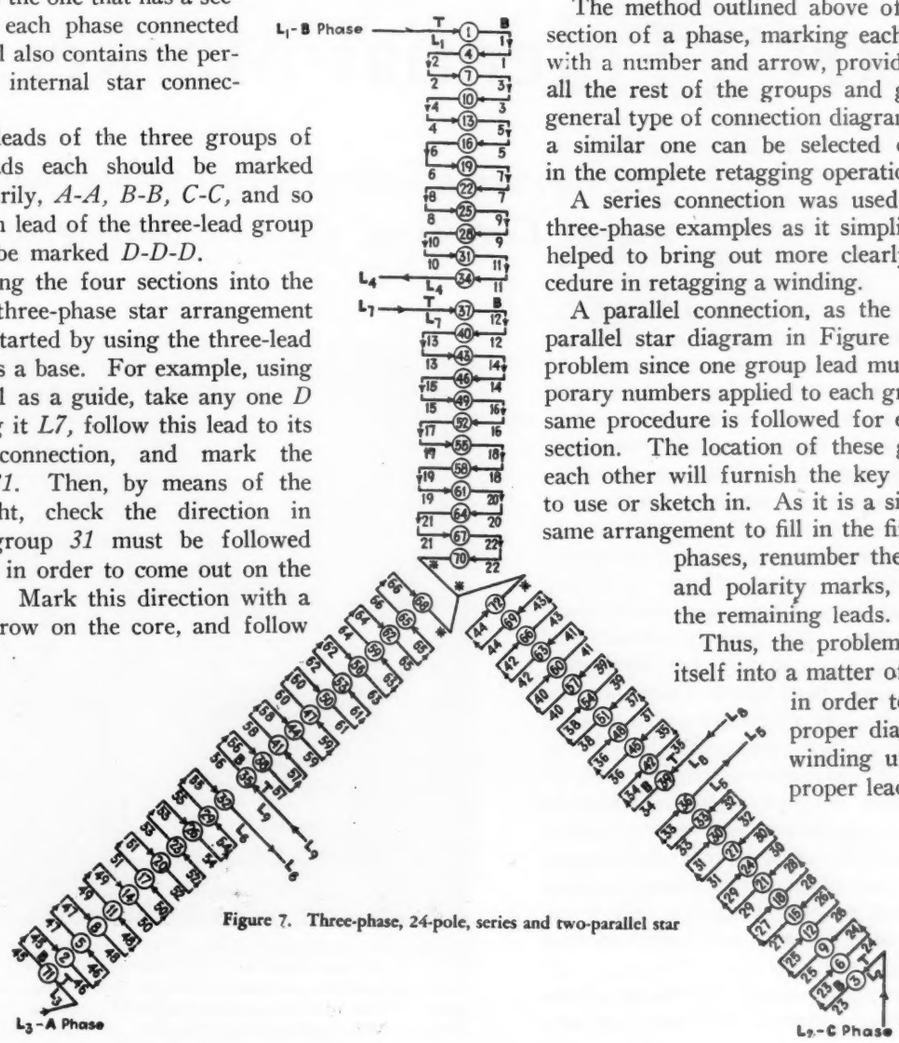
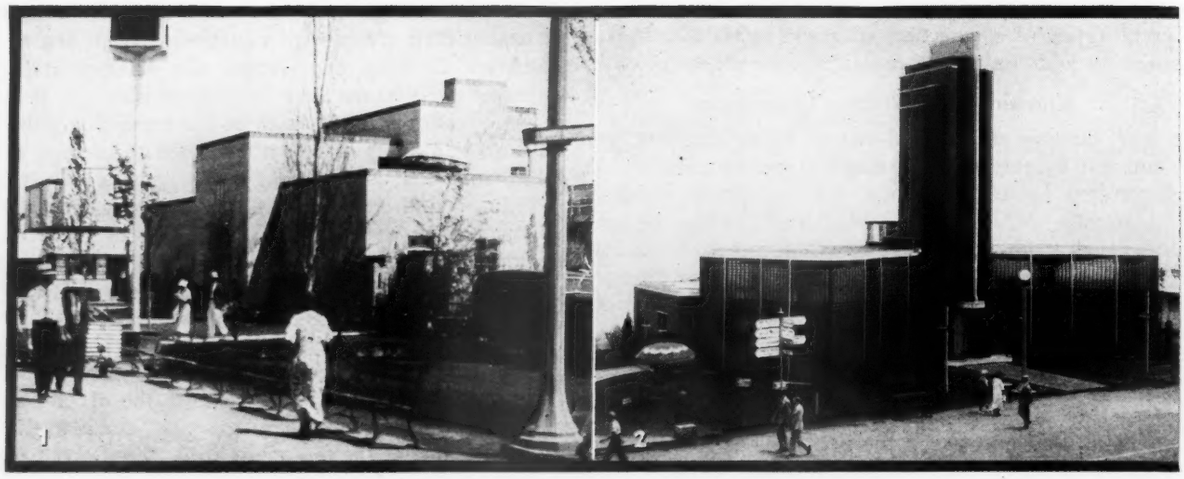


Figure 7. Three-phase, 24-pole, series and two-parallel star



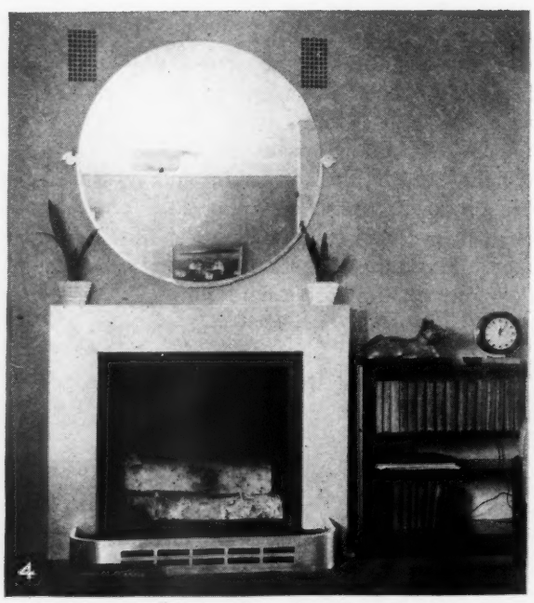
Factory-Built Houses— Industry's Potential Market

New materials and new uses of old materials seen in Century of Progress housing exhibits

WHATEVER the bankers may have been doing during the recent unpleasantness, the designers, research men, and market analysts have been busy. Any manufacturer who shares the until recently fashionable belief that all the new things have been done and that his industry might as well fold up and quit, should spend a few days at the Century of Progress Exposition seeing what others have done and what are likely to be some of the new currents of popular demand which will affect his business soon, for better or worse.

By common consent, interest seems to center in retail markets, particularly housing. The dozen or more model houses are filled from the moment they open until night with a steady stream of all sorts of people, bashful newlyweds and brides-to-be, farmers and doctors and teachers and business people of all ages and conditions of life. The houses and their furnishings are startling, but the transition in popular taste has gone on so long and the new things are so obviously good, that one hears few objections. These houses are creating new markets and the acceptance of new and often revolutionary methods of building. Millions of people, when they get home, are going to give sympathetic ear to new merchandising campaigns.

First, and probably most significant, are the new types of residential construction. Armco's frameless sectional



4. New materials, new styles. The mantel in this Armco house is of aluminum in a brushed finish. The clock is black and white in one of several interesting new designs. Note ventilating louvers over mirror, and ceiling lighting fixture reflected in mirror

1. The Rostone house. Walls of synthetic stone with lugs cast in, secured to light channel steel frame. Note flat roofs, giving outdoor living space. In background, the Masonite house, of a wood composition board. Upper foreground, one of the broadcasters which dot the grounds

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2. A glimpse of the future is given by this building, constructed of transparent glass brick, clear and in colors, hollow for insulation

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3. The Armco porcelain enameled-steel house. Sections are pre-fabricated to the customer's specification. Floor, walls, and roof are built in the same way. To these sections a coating of insulating material is secured by threaded nails driven into thin steel walls of the section

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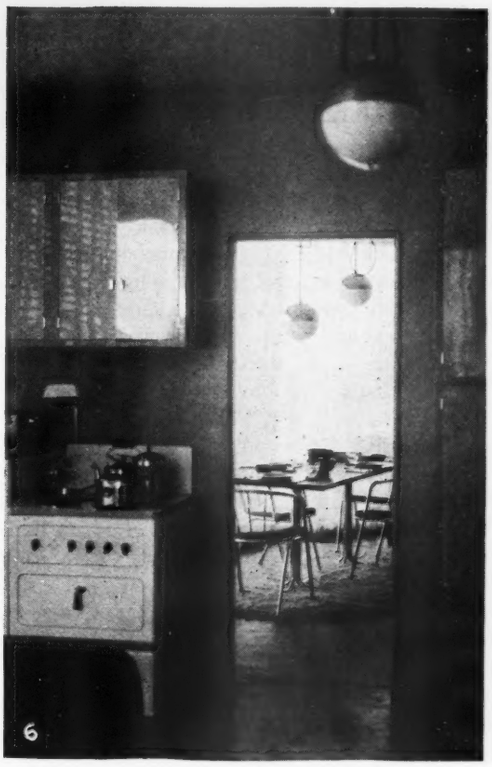
5. On the porch of the Masonite house are these featherweight, non-rustable tubular aluminum chairs. The lamp is of aluminum in a brushed finish

6. This view from kitchen into dining room shows a bit of the "House of the Future." The outer glass wall in the dining room is shielded by a sheer white curtain, while the rolling slat shades in the kitchen are reflected in the mirror-like enameled-steel cabinet at the upper left. The dining table comes apart into a pair of bridge tables. Note metal chairs, electric stove, and lighting fixtures. In spite of its revolutionary construction, this house presents a most attractive interior



house is revolutionary, and if it proves out economically and from the standpoint of durability as well as it seems to in its appeal to popular taste, should make and unmake markets. There is apparently a wide tendency to substitute sheet material, of enameled steel, synthetic stone, plywood, or composition for the conventional masonry, plaster, or wood siding, both outside and inside the house. Basements give way to compact utility and laundry rooms. Coal, if it is to be delivered to these new houses, must probably come in small quantities and prepared form. Roofs are flat with two exceptions. In general, house erection will tend more and more to be an assembling job, with virtually all forming operations performed in the factory.

A second interesting angle is the use of new materials and of old materials in new forms. Aluminum is probably the most conspicuous of the new materials, appearing in furniture, mantels, staircases—including frames, treads, and rails—floor lamps, aluminum foil for insulation, aluminum paint, and various other applications. Stainless steel and monel metal are apparently the fashionable materials for kitchen sinks, drains, and similar applications, and also appear in some of the outdoor fittings and furnishings. Polished opaque glass,

often in black onyx effect, is another popular decorative material.

The use of plywood for furniture is rounding the corners of dressers, chairs and tables. Graceful and practical; also, you don't bump your shins in the dark. The synthetic resins are invading the furniture field, especially in the way of molded handles for drawers and like applications. A group of rooms show synthetic resins in wide variety of household applications including floor and wall coatings for kitchen sinks and similar products, molded clock cases, and many other applications. Copper tubing is featured for plumbing. New types of paints and finishes appear. An interesting detail is the use, in the model houses and in many of the other buildings, of pre-finished wallboard to which wood veneer, metal foil, or other finishes had been applied directly; also the use of sound-insulating fiberboard or composition ceilings.

The new houses, by the way, are not the only illustrations in the Fair of new uses of materials. Aluminum railway cars and truck bodies, glass-enameled tank cars, new steel and bronze alloys, and new finishes are widely in evidence. The Fair buildings are a standing example of the use of plywood and composition board.

A third impression is of the progress of industrial design. This is perhaps most obvious in the automobile exhibits, where "gasoline buggy" and streamlined roadster stand side by side. A first point is articulation. The old car is an assemblage of ill-fitting and unrelated attachments. The new car, no matter how many producers may have a hand in its final completion, is built as a unit. Second, there is the abandonment of tradition and the adaptation of form to use.

Houses show similar trends. The carpenter, mason, and electrician of the future will be almost exclusively assemblers of pre-fabricated and unit-assembled materials. Probably these materials will be standardized in unit dimensions, but there seems no special tendency toward the monotony of complete standardization.

Some of the furniture and some house furnishings are almost as beautifully thought out in detail as a modern automobile. There is the chaise longue, with breakfast tray which just fits over the adjoining bookcase after use. There are the beds with built-in sidelights, the electric stoves with attached timepieces and lights and time control of heating, the dining tables which double as bridge tables. Small houses, saving steps and cost yet achieving spaciousness by simplicity and ingenious compactness, seem the trend.

Artist and interior decorator have had their day in these modern homes. Pictures, statuary, and furniture are modernistic. The "Design for Living," with interiors by Gilbert Rhode, is a particularly interesting and sophisticated job, but it is only one of several houses notable for simplicity with arresting points of unexpected interest, and an impression of repose and livability.

The model houses offer suggestions to many lines outside those directly concerned with residential construction and household utilities and furnishings. Possibly the high point of the Exposition from the standpoint of market and design interest, they are far from being the only significant industrial displays.

Come to the Exposition with these specific questions in mind—you can formulate others when you get here:

1. What are the tendencies in my present markets? Are they growing, or threatened by substitutes or changes in habits of living? What must I do to direct my business back into the main current of active demand, if that is indicated?

2. How does my product stand up alongside those on exhibition? Is mine thought out, finished? Does it use materials economically, suitably? Is it in style? Is it serviceable? Shoddy or clumsy products now made can be sold only because the buyer is not a discriminating judge of value. And the buyer is rapidly being educated to discrimination.

3. Can I borrow new ideas and apply them to my product? New materials? Built-in or integral construction of elements logically a unit but by tradition sold in separated parts, as lights on stoves or beds, finish on walls, and so on? New constructions, as reinforcement, borrowed by brick from concrete? Color? The Fair is full of new and striking applications of color. Adaptations to use—streamlining, rounding corners, rustproofing, insulating, surface hardening and protection, reduction of weight, shake- and use-proof attachment, and so on?

In one of the halls is a little booth, in which a manufacturer of needles displays as side lines sponge-rubber scalp massagers, a patented check for screen doors, tin spoons, and at least half a dozen other assorted articles. The display illustrates one solution of the problem of reduced volume.

7. This glassed-in penthouse opens onto the open deck of the Armco roof. The swinging chair has seat and back of thin-gage steel, very comfortable. The enameled-steel wall construction, of plates held by rustless strips, can be seen. These strips are secured to the "corrugated" steel sections which compose the structural part of the wall

Yet it seems that the Fair as a whole offers heartening evidence that the way to industrial recovery lies not in invading the other fellow's market, justifiable though this step may sometimes be, but in applying imagination, backed by research and investigation, to the task of improving and reducing the cost of one's own processes and products so that serviceable and beautiful houses, and recreation, and protection, and adequate ministering to all the basic human needs may be available in richer and fuller measure to more people.

A portable booth is set up in the department to prevent undue time loss while workers have their eyes examined

Eyes Have They—

—but they do not all see. And defective vision leads to accidents, results in fatigue, poor workmanship, unnecessary expense. The United States Metals Refining Company has its employees' eyes examined "on the job" to the benefit of all concerned

Robert Winters

Superintendent of Industrial Relations
United States Metals Refining Company, Carteret, N. J.

ONE HALF of all industrial employees have defective vision. Eighty per cent of a worker's muscular activity is directed by his eyes. Sixty per cent of his education comes from his eyes. A person with normal vision uses 40 per cent of his energy in seeing. Fifteen per cent of industrial accidents result from defective vision. Six of every ten headaches are caused by the eyes. That's why fifty per cent of this country's industrial plants now have employees' eyes examined.

For years industry has been protecting its eyes with goggles and has devised and used safeguards to prevent injury to the eyes. An estimable action. But, lately management has awakened to the fact that the eyes are not only important for themselves. In many cases it is the fault of the eyes when an arm or a leg is lost. To be sure most companies subject prospective employees to a physical examination which includes the eyes, but these examinations perforce are only superficial, and many a man gets by who has but one good eye or even only partial vision with them both. And if such a worker be set to operate a crane, a saw, or a ladle, he is a menace to himself and to all who must work with or near him. To say nothing of his low efficiency as an accurate worker.

It is the accident hazard which leads most companies to have their workers' eyes examined, but there are several other sufficient reasons. Increased efficiency due to better vision, for instance, means more and better production, less waste.

Here is how the examination program worked out in our plant; not much different in essentials from hundreds of others.

In 1930 we decided to institute a program of eye examination of employees at our Carteret, N. J., plant, in connection with our already well rounded safety program.

By arrangement with the Kindy Optical Company of Philadelphia, actual examinations were begun in the fall of 1930, and the final report was finished in March, 1931. Since the plant covers over a hundred acres, the optometrist's equipment was set up in a suitable place in each department so that time lost from work by employees visiting the inspector's booth would be minimized. A separate record was made for each individual examined and in cases where the need for glasses was revealed, a prescription was given on the record.

The examination cost the employees nothing. It cost the company little more than the few minutes each employee missed from productive work while the examination was being made in the department. And if the worker was found to have eyes that were dangerously

What the Survey Showed

Number of employees examined	1,180
Employees having normal or nearly normal vision without glasses and not needing optical service (62 per cent)	733
Employees having defective vision made normal with glasses previously purchased (11 per cent)	131
Employees wearing glasses which needed changing and were changed (5 per cent)	70
Employees with defective vision, not wearing glasses, needed them, got them (11 per cent)	134
Employees wearing glasses which needed changing but did not have them changed (2 per cent)	30
Employees with normal or maximum vision possible before survey (74 per cent)	865
Employees with normal or maximum vision possible after survey (90 per cent)	1,068
Employees increased to normal or maximum vision during survey (16 per cent)	203
Amount of improvement in vision gained by those who took advantage of the survey (23 per cent)	
Amount of improvement in vision that could have been gained by those who did not take advantage of the survey (17 per cent)	
Employees whose vision in one or both eyes was 50 per cent or less and whose vision could not be improved with glasses above 50 per cent (2 per cent)	27
Employees found to be blind in one eye	4
Employees referred to medical attention	7
Employees found to be color blind	100

bad, he did not have to worry about losing his job, since the only basis on which these examinations can be conducted satisfactorily carries with it assurance to the worker that a poor report means only transfer to some other work less dangerous to himself and others.

In the original survey, 1,180 examinations were made. The report covering these examinations is classified and coded. A tabulation herewith shows its major findings, but there is a special division of the report which points out to the company by name, department, clock number, and position, those employees whose vision in one or both eyes is 50 per cent or less and which could not be improved with glasses above 50 per cent. This does not include those with blind eyes, listed separately.

A glance down this list reveals the following cases: a fireman in the yard, a handy-man in the casting department, a crane operator, a man engaged in weighing, a safety watchman, a puncher, a track-man, a fireman in the smelting department, a pipe fitter, a sheet flopper, a locomotive engineer, and a truckman. There are several others on the list, but those mentioned indicate the possibilities for accidents, considering the work these men were doing and the condition of their eyes. Add to these, 100 employees found to be color blind. The implications are obvious.

When we saw this, we immediately took steps to transfer those we considered dangerously located into other types of work where defective vision had less chance of causing accidents. As for those of the employees who could benefit by having glasses or by a change in glasses, we took the attitude that these persons should be so informed, but that no coercion should be used to make them buy the glasses.

An eye examination program should not, however, end with the original survey. It should provide for re-examination at regular intervals. The program at U. S. Metals calls for complete re-examination of all employees every two years. The reason for this lies in the fact that a person's eyes undergo slow deterioration with advance in age. And if the lighting conditions in the work area are poor, the change can come quite rapidly. Eyes that tested nearly perfect in the original examination may be found two years later to have decreased markedly in efficiency.

There is also provision to be made for examination of the eyes of new employees. This is taken care of at U. S. Metals by having an examination made as often as the number of incoming workers not yet examined amounts to 200 approximately.

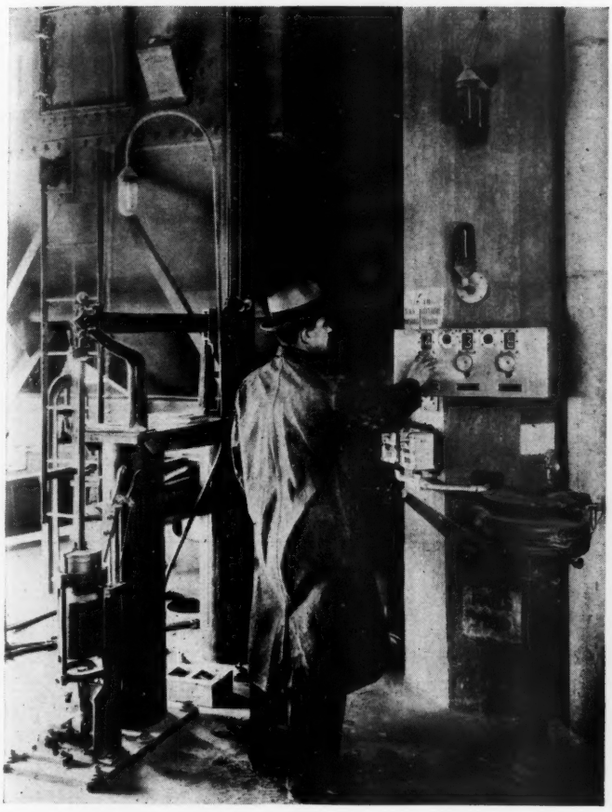
As a part of the survey it is often helpful to have an illumination expert go through the plant and check up on the lighting conditions. This was done at U. S. Metals. Before the actual work of examining eyes was started the Kindy company sent its safety man, illuminating expert, and optometrist in charge to make a tour of the plant. Glare, lack of sufficient illumination, and shadows cause eye strain. It was felt to be as important to avoid the causes of faulty vision as to correct the vision after it had become faulty.

Also, at the start of the program, a moving picture was shown the employees. It depicted the effects of poor vision and the manner of conducting the examination. Object: to assure the cooperation of the workers.

It is, of course, impossible to arrive at any dollars-and-cents estimate of the amount of saving such a program of eye examination effects. But anyone can easily see that there must be beneficial results, not only in reduced accident rates, but in the better health, better eyesight and freedom from strain and consequent fatigue which make any employee more valuable to his company.

This we can say, "While we do not attribute entirely our continued reduction of accidents over a period of years to the improvement made by the survey, we have not doubted that the survey has helped in a general way in the reduction of accidents and in increasing operating efficiency."

SHORTS FOR MANAGEMENT FOR MAINTENANCE



Visual Signals Keep Dispatching Straight

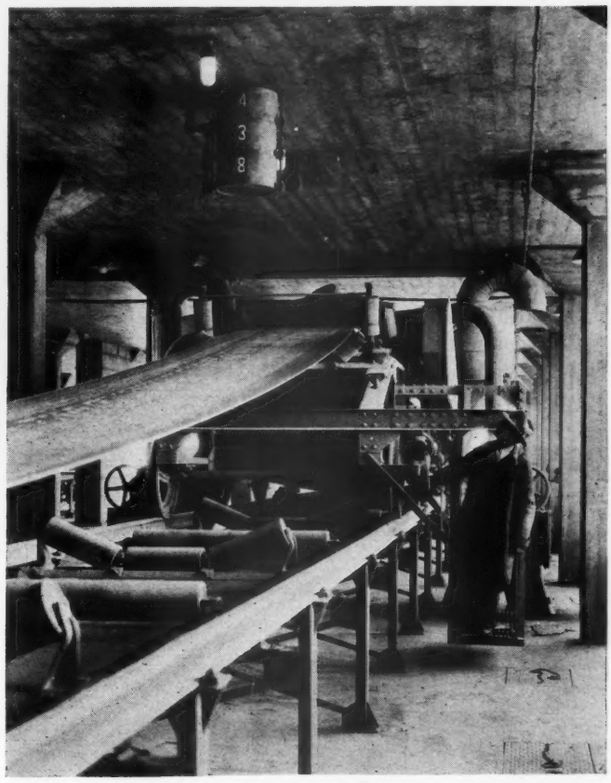
JOHN H. BEHL, Electrical Engineer, Reading Railroad

Audible systems of communication can be unreliable when the rumble of moving belts and the clatter of machinery are added to the noise of grain sliding down chutes. Hence visual position indicators are used in the Reading Railroad's grain elevator at Port Richmond, Philadelphia, to control the flow of various kinds and grades of grain over several dozen belts to the right bins.

Operators use the visual indicators to signal to various men about the plant the disposition of the grain on each belt. Cars are unloaded by tilting car dumpers. The weigh-master on the scale floor dispatches the grain to the storage bin specified on a ticket supplied him with the car. To transmit this number to the head binman, he first calls the latter to his office by a bell. In the binman's office are a bank of numerical transmitters, one for each of the transmitters on the scale floor. The weigh-master lights a lamp on the indicator for the belt on which the grain is to be received, and sets the number (438 in the accompanying photograph) of the bin to which the grain is to be sent. As he does so, the binman's indicator shows the same number.

As a check, the binman now repeats this number to the weighmaster. If repeated properly, the latter signals to the binman to set the tripper over the proper hatch. As shown in the second photograph, the binman does not trust to memory but is guided by indicators spaced at intervals along each belt, which show at all times the same numbers as the control indicators in the binman's office and on the scale floor. The tripper set, the binman signals, by a light, to the weigh-master to send up the grain.

With this system there is visual indication during the entire movement of grain. There can be no dispute as to whether, say, bin 438 or 483 was called out.



Higher Power Factor, More Generator Capacity

J. ELMER HOUSLEY, Alcoa, Tenn.

Raising the power factor from 75 per cent to 95 per cent on a 5,000-kw., 25-cycle industrial plant load became necessary, in order to increase the generator capacity and secure rated voltage.

Conditions in the plant were not favorable to the installation of synchronous motors because of the presence of dust and chemicals. So it was eventually decided to install a 2,500-kva. synchronous condenser in the powerhouse turbine room. This location was dictated

by favorable cost, and good operating conditions; trained men could supervise the operation and the switchboard operator could handle the voltage regulation to suit plant conditions by occasionally adjusting the automatic power factor regulator provided with the condenser.

The condenser improved the voltage regulation from a range of 80 volts (440-volt bus) to a range of 10 volts, or from 20 per cent to 2½ per cent. The station exciter bus voltage was decreased from 140 to 120 volts, and the load reduced 27 kw. on the exciter motor. It was found that stability was improved on the tie line between this power plant and another private plant located 1 mile distant. After the power factor was raised to 95 per cent the generating capacity was increased 400 kw. on account of the decreased heating.

•

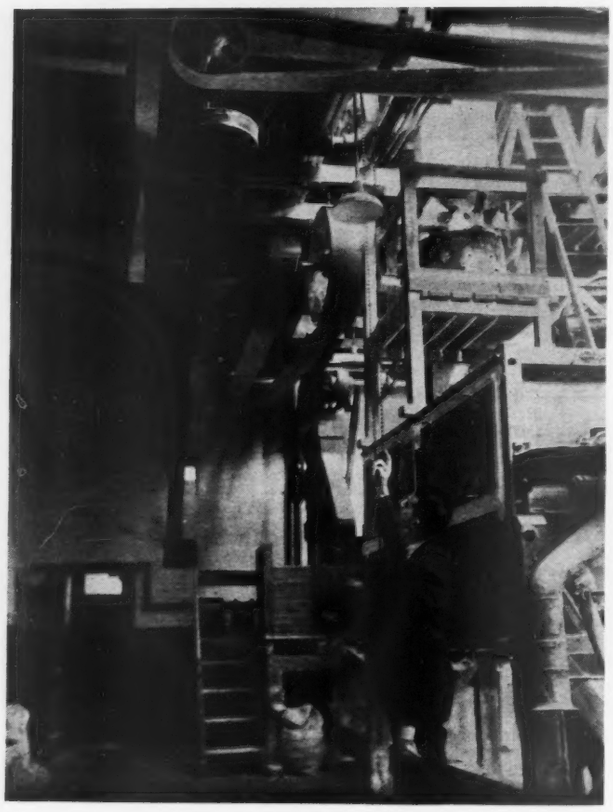
Saves $40 a Month By Correcting Overmotoring

GEORGE A. EHRHARDT, Chief Engineer
Haberland Manufacturing Company, Allwood, N. J.

A simple overmotoring correction saved a manufacturer of sizings and finishings for textiles $40 in monthly power bills through a reduction in maximum demand charges and a more efficient motor use.

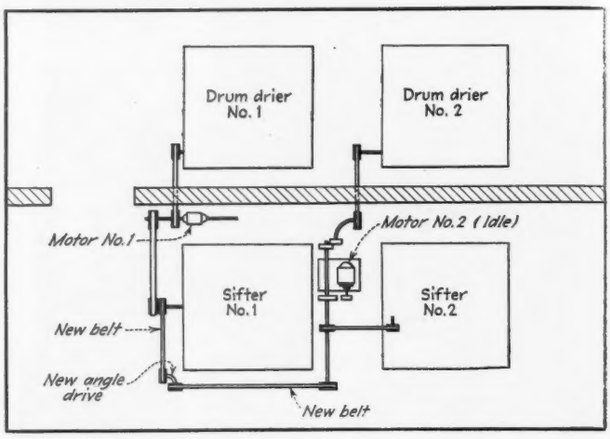
In one section of the plant two identical groups of equipment, each consisting of a drum drier mill and a sifter, are set up as indicated on the schematic drawing.

Belt connection from each sifter motor to drier is had through holes in the dividing wall, as seen in the upper illustration. The exhaust blower, with its present lineshaft drive, is located in an end room. It serves six driers throughout the plant.



Formerly a 30-hp. motor drove each of the two drier-mill and sifter groups in question. But because of the high drier efficiency, one drier was invariably used with two sifters. Nevertheless, both motors had to be run, with one grossly underloaded.

Installing the angle drive, toward which the engineer is pointing, enabled both sifters and mills to be run



from one sifter-drier motor, which thus operates at high efficiency. Motor No. 2 was not removed; if the second drier should ever be needed, the old belt connection could easily be re-established.

By decreasing the blower speed 10 per cent, which still left it with sufficient suction for the driers, its 15-hp. motor could be eliminated, and belt drive to an existing lineshaft made as shown.

•

Wrong Is Righted

A. V. LEVERING, Chicago, Ill.

A method employed at Stewart-Warner Corporation, Chicago, to assure absolute accuracy of coils in the radio receiving set department may conceivably not be applicable in its exact form to any job but coil manufacture. The principle, however, is so startling that it must have a good many applications in wholly unrelated lines of manufacture.

Absolute accuracy in apparent inductance is essential. No limits of tolerance can be allowed, otherwise the completed set will be unsatisfactory. The variables are many—accuracy of gage of the wire, quality of the insulating enamel, spacing between wires in the coil, and so on. So, instead of attempting to control all of these factors in advance of making the coil, and then having to reject those completed coils which are less than perfect, the approach has been entirely different. Each coil is made intentionally inaccurate on one side, and it is then repaired by a simple operation which brings it to absolute accuracy as respects apparent inductance.

Each coil is wound three turns of wire more than would be needed if all conditions could be controlled exactly. Then the coil is tested on a tester tuned to the circuit in which the coil will be used. Of course the coil

is wrong—but always in the same direction. The coil is held on the tester on an arm which may be rotated. This shifts turns of wire to the right, far enough away to lose most of their inductance value to the coil. When the originally faulty coil is placed in the tester, heterodyning is heard. Turns are shifted until the sound ceases. Thus absolute accuracy in the coil is assured.

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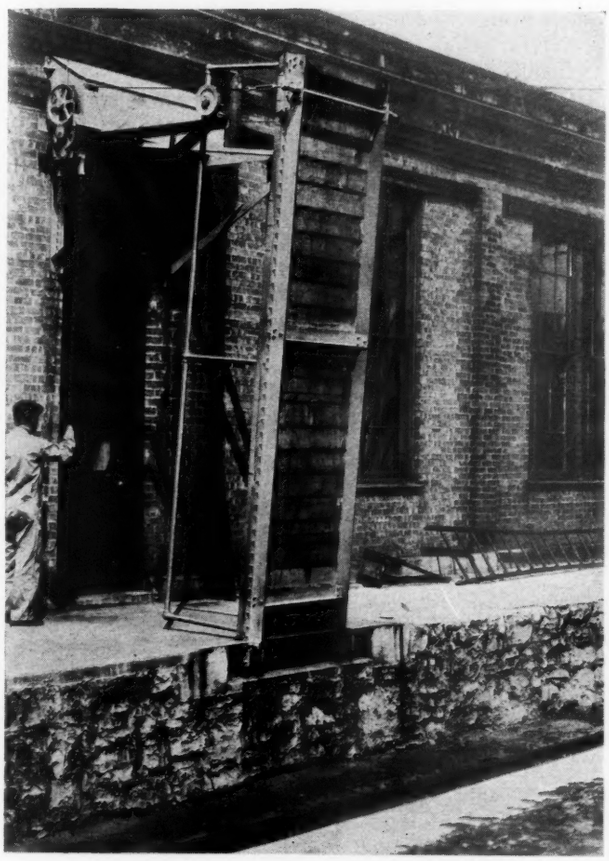


For That Crossing of Yours

A Columbus, Ohio, concern that manufactures rolling steel doors and shutters has had no cross-over problem since it developed this drawbridge some six or seven years ago. It worked so well that the company has decided to let others in on a good thing; is now offering drawbridges to all comers

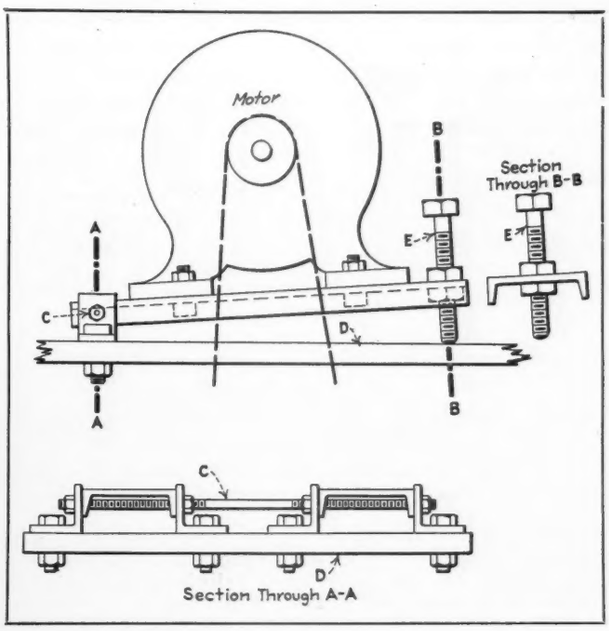
•

Motor Base and Belt Tightener For Vertical Drives

CHAS. A. PETERSON, Mishawaka, Ind.

An efficient slack belt adjuster for vertical drives is shown by means of the accompanying sketch.

By referring to the section view through AA it will be seen that the motor is mounted on channel iron which forms the motor base. Adjustment for various motor widths is made by means of the tie rod *C*. At *A* the channel iron is pivoted to the platform *D*, with the free end arranged to be raised or lowered through the use



of the threaded bolts *E*. The section at *B* shows this arrangement. Adjustment of the belt is made by raising the motor the distance necessary.

•

A Problem in Arc-Welding Control

ELLIS MILLS, Chief Electrician
Willys-Overland, Ltd., Toronto, Ont., Can.

A single-operator arc-welding generator will operate only one arc satisfactorily; but the foreman of our body plant suggested that a second welding lead be connected to our welding generator to allow two operators to work simultaneously. We decided to try this, despite the manufacturer's statement that it would not work.

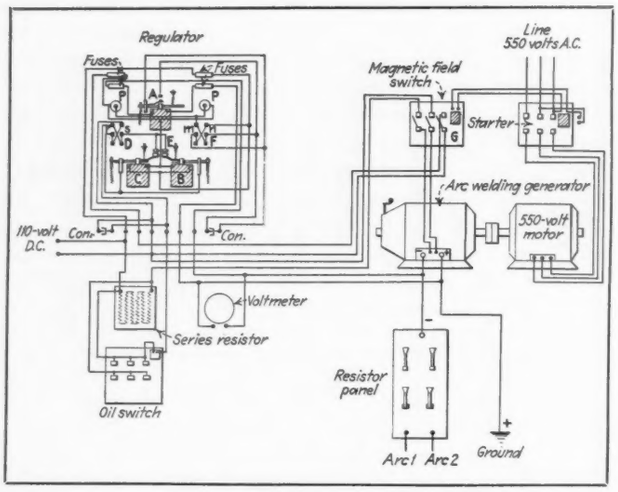
As expected, the results were unsatisfactory. In order to obtain sufficient current to maintain two arcs, it was necessary to move the current regulator to maximum position. This started difficulties for the operators. When the two men drew arcs together neither could obtain enough current to weld properly. The voltage of the machine dropped badly, and when one operator extinguished his arc the voltage of the machine rose rapidly and the second operator received a rush of current sufficient to burn holes in the work.

It will be seen that the installation of series resistors in each welding lead would not in itself have solved the problem, because the amount of current that could be drawn was governed by the voltage of the machine.

The generator is rated at 300 amp., and is self-excited, with adjustable brush rocker for current regulation. It was mounted on a platform together with an alternating current driving motor with push-button starter.

With one operator working, and with the regulator set for 150 amp., the voltage at the machine terminals was 60 at no load and 20 at working load.

To improve the current regulation, I decided to excite



Under normal operation all the contacts at magnetic field switch *G* are closed, the series resistance is in the generator field circuit, and the generator is delivering more than 60 volts. This means that contact *A* is open.

Also, under normal conditions, there is a continuous circuit from one 110-volt d.c. line, through the two pilot lights *P* (in parallel), through the two secondary relay coils *C* and *B* (wchich also are in parallel), and back to the other 110-volt d.c. line. This means that the contacts at *E* are open.

When the voltage of the generator goes below 60, contact *A* closes, shorting the mid-points of switch *F*. No matter which way the double-pole, double-throw switch *F* is thrown, shorting the mid-points is equivalent to shorting terminals *m* and *n*. This means that the coils *C* and *B* are shorted out.

This means that contacts *E* close, and the lights attain full brilliancy, because they are now directly across the line.

Closing contacts *E* is equivalent to putting a short across the mid-points of the double-pole, double-throw switch *D*. No matter which way the switch is thrown, this is equivalent to shorting points *r* and *s*.

Shorting *r* and *s* puts 110 volts, d.c. across the closing coil of the oil switch, so that it closes and shorts out the resistance.

This then causes the generator voltage to rise, and as soon as the voltage reaches 60, contact *A* opens, coils *C* and *B* are once more energized, and pilot lights dim. Contacts *E* open, the holding coil of the oil switch is de-energized, the oil switch opens, and resistance is once again inserted in series with the generator field.

Thus pilot lights are used primarily as series resistors with coils *C* and *B* in order that short circuit will not be established when coils *C* and *B* are shorted out.

The two double-pole, double-throw switches are used to reverse the direction of current flow through the master and secondary contacts, which greatly lengthens their useful life.

the shunt fields separately from our 110-volt service. A special resistor was built in the shop for reducing the voltage to 60 as required. I realized, however, that the machine voltage would drop excessively if two arcs were used.

To overcome this difficulty a vibrating type voltage regulator was designed and built in the shop. An auxiliary oil switch shunts the series resistance, because the secondary relays could not break the heavy field current effectively. The operation of the regulator, which comes into action when the machine voltage drops below 60, is shown in the accompanying figure.

The voltage regulator and oil switch were installed in the electrical station where the direct current is generated. Control lines were run approximately 600 ft. in conduit to the welding generator in the metal shop. A magnetic contactor was installed at the machine and its operating coil connected in parallel with the operating coil of the linestarter of the driving motor. This arrangement takes care of the field current, switching it on and off automatically as the machine is started or stopped. The third set of contacts is utilized to open the supply of the regulator. A small transfer switch was installed on the machine to enable the operator to change the shunt-field from separate excitation to self-excitation for light welding, or if the direct-current supply is not available.

Our next problem was to build a resistor panel which would limit the current to each arc. We designed this so that the brush rocker on the welding generator could be left at the maximum position for all work while the separate excitation was being used.

With the reduction of energy losses in mind, we paid particular attention to the return lines of the system. The work on which the welding is done is mounted on steel trucks which travel down the production line on steel channel rails laid on the floor. The operator depended for his return circuit on thin strap iron welded to the rails.

To remedy this condition and to make the return as efficient as possible, a 500,000 circ.mil cable was installed from the machine to the basement immediately under the tracks, and joined to a 500,000 circ.mil cable running across the basement ceiling. Slots were cut in the floor, and copper bars bolted to the tracks and extended through these slots to the basement where they were jointed to the main return cable with 0000 leads. The metal-topped welding tables were also connected through the floor to the cable. This made a very efficient circuit.

The only difficulty experienced now with the installation occurs when the welder accidentally short-circuits the electrode holder with the track while the second arc is in operation, causing an overload on the driving motor, and occasionally tripping out the thermal overload relay on the starting contactor.

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Those Grease Cups

JOHN E. HYLER, Peoria, Ill.

One thing which makes the maintenance man use all the forebearance he has in order to avoid saying something he shouldn't, is the out-of-the-way bearing that is fitted with a grease cup. And because it is so hard to get at, the operator or oiler neglects to give it the periodic turn requisite to proper lubrication. The result is early failure of the bearing.

One way to keep such bearings from being neglected is either to solder or weld to the cup a long slender handle made from light rod or heavy wire, so that the operator won't have to stand on his ear to give it a turn.

A couple of grease cups in the maintenance man's kit make excellent containers, by the way. Pipe-joint compound is one thing that can be conveniently carried in the kit in this manner. Soldering flux is another. And even a cup filled with grease sometimes comes in handy. Cup grease will hold shims in place on the under side of a bearing until the cap has been applied.

Delivers the Goods

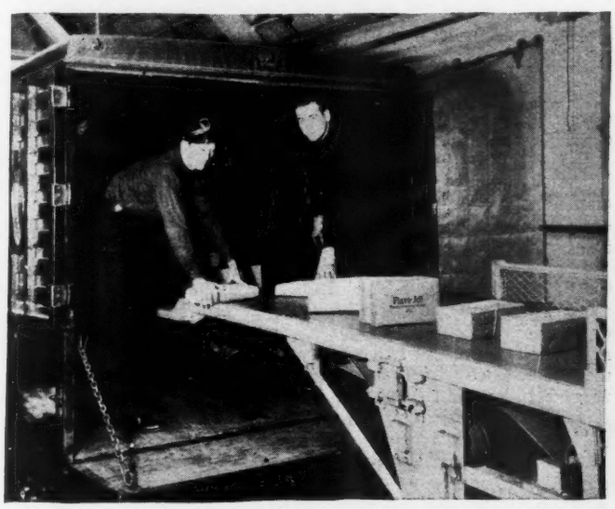
SOURCE: United Parcels Service, Los Angeles

The conveyor you're looking at was caught "delivering the goods" in a sunny California shipping room. When we tell you what a great job it does, you'll wonder how your plant or any plant with a considerable shipping problem has lived all these years without one.

It is actually a short section of belt conveyor. Has casters so you can wheel it all over the lot. And of course it has a motor all its own. A very self-contained little piece of equipment.

See how it works? Packages ready for delivery shoot the chutes onto the loading platform. The little belt conveyor's there ahead of them. It has been shoved into place at the bottom of the chute and proceeds at once to justify its existence by picking up the packages and carrying them right into the truck—much to the evident satisfaction of the two young men who had their pictures taken. They are spared many steps and a deal of lifting. All of which cuts loading time plenty, enables truckers to spend a larger proportion of the day on productive service.

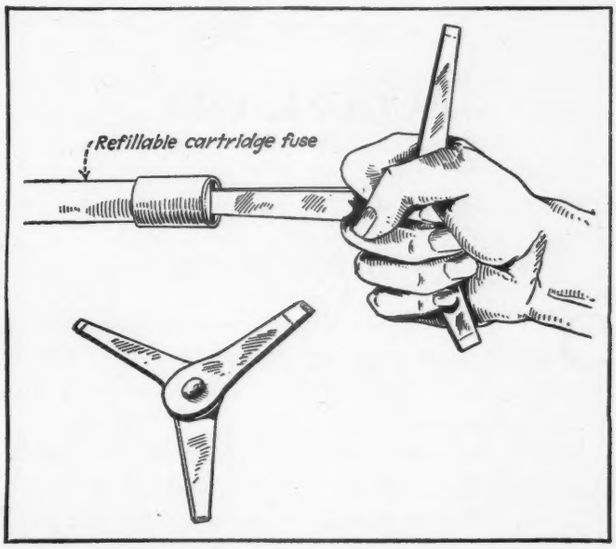
Variable-speed drive is one of the features of this portable unit. Naturally if there's only one man on the receiving end of the conveyor, it may be necessary to slow down. Or conceivably something about the size and shape of the packages being handled at a specific moment may make it desirable to vary the speed.



Guide for Commutator Undercutting Saw

W. E. WARNER, Welwyn Garden City, Herts, England

A handy guide when undercutting commutator mica can be made from a piece of sheet metal, as long as the commutator is wide, and one and a quarter times as wide as a bar. One of the lengthwise edges of the strip is bent at a right angle and trimmed up with a file so that it will fit into the recess between two bars after the mica has been undercut. The other edge should then be trimmed with a file so that it comes flush with the other edge of the bar and can serve as a guide for the saw while undercutting the next mica, and go on around the commutator. If the guide is held flat in contact with the commutator, there is no risk of its moving or not guiding the saw properly.



Handy Pocket Screwdriver

CHAS. H. WILLEY, Penacook, N. H.

The accompanying sketch shows how a folding tee-handle screwdriver can be made from thin sheet steel stock or from the ends of broken hacksaw blades. Three different point widths are provided. When one point is in use the other two form the handle.

Heavy Handling Specialist

An industrial tractor is nice to have around when plant layouts have to be changed to meet today's conditions. This one makes light work of the oft-photographed job of hauling a heavy piece of machinery down the main aisle of its new location. A Chicago plant uses one of these tractors to supplement other handling equipment, finds it especially useful in pushing loaded freight cars around

Factory Management *and* Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

L. C. MORROW, Editor

AUGUST, 1933

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Reemployment

OUTSTANDING development of the month in the recovery program was the "President's Reemployment Agreement." A progressive, aggressive, necessary step.

Taken in small bunches (the administrator's staff is limited), all the codes would eat up a lot of time. Before the last was approved the first would be ancient history (relative tempo). Increments of purchasing power would not have rolled up with the rapidity necessary to squelch an adult depression. Some industries would have been in no hurry to enter the corral.

The intent of the agreement is to give a sudden lift to purchasing power all along the line. The President admirably outlined purpose, policy, and procedure in his radio talk of July 24. Showed that he is trying to reverse direction on the vicious circle around which prices and production, wages and workers have been chasing each other for nearly four years.

The trial is easily worth the effort, deserves that large measure of cooperation without which it must be ineffectual.

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The Agreement Itself

(*Authorized by Section 4a National Industrial Recovery Act.*)

DURING the period of the President's emergency reemployment drive, that is to say, from August 1, to December 31, 1933, or to any earlier date of approval of a Code of Fair Competition to which he is subject, the undersigned hereby agrees with the President as follows:

(1) After August 31, 1933, not to employ any person under 16 years of age, except that persons between 14 and 16 may be employed (but not in manufacturing or mechanical industries) for not to exceed 3 hours per day and those hours between 7 a.m. and 7 p.m. in such work as will not interfere with hours of day school.

(2) Not to work any accounting, clerical, banking, office, service, or sales employees (except outside salesmen) in any store, office, department, establishment, or public utility, or on any automotive or horse-drawn passenger, express, delivery, or freight service, or in any other place or manner, for more than 40 hours in any 1 week and not to reduce the hours of any store or service operation to below 52 hours in any 1 week, unless such hours were less than 52 hours per week before July 1, 1933, and in the latter case not to reduce such hours at all.

(3) Not to employ any factory or mechanical worker or artisan more than a maximum week of 35 hours until December 31, 1933, but with the right to work a maximum week of 40 hours for any 6 weeks within this period; and not to employ any worker more than 8 hours in any 1 day.

(4) The maximum hours fixed in the foregoing paragraphs (2) and (3) shall not apply to employees in establishments employing not more than two persons in towns of less than 2,500 population which towns are not part of a larger trade area; nor to registered pharmacists or other professional persons employed in their profession; nor to employees in a managerial or executive capacity who now receive more than $35 per week; nor to employees on emergency maintenance and repair work; nor to very special cases where restrictions of hours of highly skilled workers on continuous processes would unavoidably reduce production but, in any such special case, at least time and one-third shall be paid for hours worked in excess of the maximum. Population for the purposes of this agreement shall be determined by reference to the 1930 Federal census.

(5) Not to pay any of the classes of employees mentioned in paragraph (2) less than $15 per week in any city of over 500,000 population, or in the immediate trade area of such city; nor less than $14.50 per week in any city of between 250,000 and 500,000 population, or in the immediate trade area of such city; nor less than $14 per week in any city of between 2,500 and 250,000 population, or in the immediate trade area of such city; and in towns of less than 2,500 population to increase all wages by not less than 20 per cent, provided that this shall not require wages in excess of $12 per week.

(6) Not to pay any employee of the classes mentioned in paragraph (3) less than 40 cents per hour unless the hourly rate for the same class of work on July 15, 1929, was less than 40 cents per hour, in which latter case not to pay less than the hourly rate on July 15, 1929, and in no event less than 30 cents per hour. It is agreed that this paragraph establishes a guaranteed minimum rate of pay regardless of whether the employee is compensated on the basis of a time rate or on a piecework performance.

(7) Not to reduce the compensation for employment now in excess of the minimum wages hereby agreed to (notwithstanding that the hours worked in such employment may be hereby reduced) and to increase the pay for such employment by an equitable readjustment of all pay schedules.

(8) Not to use any subterfuge to frustrate the spirit and intent of this agreement which is, among other things, to increase employment by a universal covenant, to remove obstructions to commerce, and to shorten hours and to raise wages for the shorter week to a living basis.

(9) Not to increase the price of any merchandise sold after the date hereof over the price on July 1, 1933, by more than is made necessary by actual increases in production, replacement, or invoice costs of merchandise, or by taxes or other costs resulting from action taken pursuant to the Agricultural Adjustment Act, since July 1, 1933, and, in setting such price increases, to give full weight to probable increases in sales volume and to refrain from taking profiteering advantage of the consuming public.

(10) To support and patronize establishments which also have signed this agreement and are listed as members of N.R.A. (National Recovery Administration).

(11) To cooperate to the fullest extent in having a Code of Fair Competition submitted by his industry at the earliest possible date, and in any event before September 1, 1933.

(12) Where, before June 16, 1933, the undersigned had contracted to purchase goods at a fixed price for delivery during the period of this agreement, the undersigned will make an appropriate adjustment of said fixed price to meet any increase in cost caused by the seller having signed this President's Reemployment Agreement or having become bound by any Code of Fair Competition approved by the President.

(13) This agreement shall cease upon approval by the President of a code to which the undersigned is subject; or, if the N.R.A. so elects, upon submission of a code to which the undersigned is subject and substitution of any of its provisions for any of the terms of this agreement.

(14) It is agreed that any person who wishes to do his part in the President's reemployment drive by signing this agreement, but who asserts that some particular provision hereof, because of peculiar circumstances, will create great and unavoidable hardship, may obtain the benefits hereof by signing this

agreement and putting it into effect and then, in a petition approved by a representative trade association of his industry, or other representative organization designated by N.R.A., may apply for a stay of such provision pending a summary investigation by N.R.A., if he agrees in such application to abide by the decision of such investigation. This agreement is entered into pursuant to Section 4 (a) of the National Industrial Recovery Act and subject to all the terms and conditions required by sections 7 (a) and 10 (b) of that act.

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The President's Statement

TO EVERY EMPLOYER: (1) This agreement is part of a nation-wide plan to raise wages, create employment, and thus increase purchasing power and restore business. That plan depends wholly on united action by all employers. For this reason I ask you, as an employer, to do your part by signing. (2) If it turns out that the general agreement bears unfairly on any group of employers they can have that straightened out by presenting promptly their proposed Code of Fair Competition.

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The Official Badge

WORDS "NRA" and "WE DO OUR PART" are in red. "EAGLE" and the words "MEMBER" and "U. S." are in blue. Background is white, using the National Colors.

The Bulletin announcing the plan to distribute the "Employers' Badge and Cooperation" pointed out:

"For the public to do its part, it must know which employers have done their part to put our people back to work by making these Agreements with the President and by Codes. Every industry and every employer who has agreed with the President on this plan, or who has had approved a Code covering the vital subject of reemployment, will be enrolled as a member of NRA and given a certificate and a Government badge showing the seal of NRA and the words: 'Member NRA We do our part.' It will be authorized to show this badge on all its equipment, goods, communications, and premises. Lists of all employers authorized to use this badge will be on file at all postoffices so that any misrepresentation by unauthorized use of NRA badges can be prevented."

Note: NRA means National Recovery Administration. (NIRA means National Industrial Recovery Act.)

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Modernization in Order

MISUNDERSTANDING on the part of industry has introduced some sand into the Recovery carbureter.

In some quarters there has been a feeling that a moratorium on the purchase of equipment is intended. That is not our interpretation. We believe that the administration and the administrator of the Act recognize that operation with obsolescent equipment places production on a high-cost basis inimical to the public interest. That, though proposals by an industry for addition of plant capacity would bring furrows to the recovery brow, so would proposals to decry modernization.

We see in prospect no letup to management's principal job of finding ways and more ways to produce at low cost. It isn't conceivable that if the nation were to set out to build a pyramid it would do so by Egyptian methods.

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Administrator Johnson Speaking

Excerpts from statement by General Hugh S. Johnson to meeting of Associated Business Papers and National Conference of Business Paper Editors, July 14.

IN THE short time since the National Industrial Recovery Act was passed, four of the greatest industries in the country have been able to get together to frame a constitution for self-government in their industries. Whatever people may say about that law, and I, myself, think of it as an experiment—there is no question about that—it does permit something that a great many people have been seeking since the war. No small part of our recessions and peaks in business has been due to the fact that business has had no power to govern itself. The Sherman anti-trust law was wholly prohibitory; the Federal Trade Commission was purely a police organization.

A little group of men who had sat in the mobilization of business during the war—an organization that left its mark on our whole industry in a way that I think has been largely overlooked—these same men proposed this same sort of a setup where there could be some kind of an understanding between government and industry where, if industry has a plan to present in a collective fashion that is helpful, not harmful, to the public, they can come and present it and get a license and go ahead under the supervision of some governing body—not a police body, but only to see that nothing is done against the public interest.

The larger industries want to attempt that experiment and while nobody ought to sit down and tell them in advance what they ought to put in their code, what they should leave out, and how it ought to be administered, after a code has been agreed upon and after we have taken out everything that might be termed an abuse, we ought to allow these industries the widest extent we can to govern themselves for the benefit of themselves and the country. That is the theory of the operation of this law. That general purpose has been somewhat obscured in the public mind by the absolute necessity with which we are faced in this country to have an employment drive. The raising of prices and the volume of production have already unquestionably far outstretched consuming power. The things produced have

exceeded the capacity of the country to consume them in a country with 12 million people out of work.

The first phase of the operation of this law is to spread employment and try to create a consuming power for the greatest market in the world, which we undoubtedly have. The first thing to do—never losing sight of the main purpose of this Act—is to put these people back to work. If you don't do that you are going to have a crash. You will be like a man who exposed himself to smallpox and lost sight of the vaccination that was right in front of him. To see if we can start this upward spiral is the reason why we place so much emphasis at this early stage of the game on hours and wages.

I don't know how to make it clearer. I find that in dealing with the people who claim to be bewildered that they have not read the only two Bulletins that have come out from here: No. 1, the President's statement outlining the policies of the Act; and No. 2, telling how codes should be submitted.

* * *

Capital goods industries will benefit in a degree from the public works program with which I have nothing to do. Undoubtedly all industries go up together and go down together. There has been a great deal of neglect and obsolescence in this country which will have to be rebuilt. Of course, the capital goods industries will receive the benefit. They are always slower than others. I don't know how we can speed them up. We cannot change the fundamental economic principles. I think that the necessary installation of new equipment should go forward. If you stopped inventiveness and progress, that would be very stupid. I do think that for a short period it would be wise to not emphasize the installation of machinery that would tend to further reduce the field of employment. It is not our purpose here to stop economic progress.

* * *

As far as this organization is concerned I have said over and over again that it would not be used as an instrumentality for the unionization of any industry. The law provides that all codes shall provide that employees shall have a right to bargain collectively through representatives of their own choosing. . . . I am going to execute this law just the way it is written. The way the law is written is that labor shall have the right to bargain collectively, that employers must receive their employees if they come to bargain collectively, to agree not to require as a condition of employment that a man join a particular union or to refrain from joining a particular union. I have been a manufacturer and I want to say that it is repugnant to me that any man employing another man should impose such a condition. But I want to go further and say that this Act is not for the purpose of unionizing labor.

Both sides jumped the gun. Even before this Act was passed it was said that the President of the United States wanted everybody in a certain industry to join such and such a union. Then, too, I have seen things that went out saying that you could get the benefits of this Act only if you joined a company union. The purpose of the Act is not to unionize labor nor does labor have to join a company union. This was emphatically brought out in the cotton textile code—the benefits given to labor were given because the government and the industry wanted to give them to labor. For one thing, child labor for 25 years has been a blot on this country but we could not get rid of it because the employers could not act together. If a man wanted to raise the conditions of his own employees he had to look around and see what other employers were doing with their employees, otherwise the chiselers would be able to force him out of business.

The President is the final authority and I want to say that he is giving particular attention to our organization and has been posted on our activities and he does pass on every question. He keeps himself daily in touch with what is going on.

* * *

I believe that people should not sell at less than cost of production. We should have what is known as an open-price agreement—that they report their sales and the prices at which they sold.

* * *

I am not going to set up any police department, because the first person who breaks an agreement to the detriment of the other fellow will be reported and then we will ask, "What about it?" If this thing works as it is supposed to work public opinion will do to a violator all the policing that is necessary.

* * *

Merchandising prices are different from manufacturing prices but I am not concerned with the broad statement. I am not going to define it. You know what it is and in an industry everybody knows what everybody else is doing and will know when it is violated.

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Help for Machinery Industries

INDICATIVE of the growing orderly arrangement of industry in groups of natural affiliation is the recent organization of MAPI (Machinery and Allied Products Institute). It is expected to coordinate the interests of manufacturers of machinery and allied products in their relations with the National Recovery Administration at Washington.

The president is John W. O'Leary, President Arthur J. O'Leary & Son, Chicago, Past President of the U. S. Chamber of Commerce. Headquarters of the institute are at 221 N. LaSalle Street, Chicago.

Taken as a group, the manufacturers of machinery and allied products constitute one of the five largest industrial groups. If this group can be organized to be represented by a single organization, a long step will have been taken in making the recovery measures effective. Other large groups (textile, food, automotive, railroads, iron and steel) already are set up to center their activities in single associations.

Available at its headquarters is a catechism explaining the origin, aims, and purposes of the Institute. The catechism tells, also, what trade associations are eligible, what ones already belong.

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

Running A.C. Generator as Motor

We have three 60-cycle, three-phase alternators that are of the same rating, operate in parallel, and are driven by single-runner waterwheels. One alternator has the exciter for the three units belted to it. What change in field strength would be necessary in order to let the unit with the exciter run as a motor, while changing to an emergency motor-driven exciter, in case the governor belt on this unit should break? It is my understanding that this unit will not get out of step while running as a motor; hence the exciter voltage will not drop.

L.K.G.—Ravenna, Ohio

THE GENERATOR will operate as a motor practically regardless of its field strength. Whether it will remain in step during the change referred to, while operating as a motor, will depend upon its design. If it is equipped with pole damper windings on the fields it should operate satisfactorily. As a motor it will operate always at synchronous speed, which means that so long as the frequency remains reasonably constant, the speed of the generator operating as a motor will be constant. In turn, the exciter connected to it will deliver constant voltage.

When operating a synchronous motor it is desirable, as a rule, to keep the field at a value that will give 100 per cent power factor in the motor circuit, or minimum input. If, when operating as a generator, the load supplied had a low lagging power factor, the field would be high. Then, if operated as a motor with no change in the field, the power factor would change to leading in its own circuit, which might raise the system voltage. The opposite effect would result if the unit, operating as a generator, had been supplying energy to a leading power factor load, when the field strength would be low.

The proper field strength to use when operating as a motor can easily be determined by adjusting the field current until the line (stator) current is a minimum. With field currents above or below this value the line current will rise.

The generator manufacturer probably can give the desired information, but if the waterwheel runner is rigidly connected there will be some additional energy needed to drive the combination and care should be taken to lighten the load as much as possible.

C. O. VON DANNENBERG, *Brooklyn, N. Y.*

Will Low-Pressure Cylinder Carry the Load?

We have a cross-compound corliss engine that drives a d.c. generator rated 350 kw., 250 volts, 1,400 amp. The high-pressure cylinder is 16x36 in.; low-

(Continued on advertising page 34)

ANSWERS WANTED

Synchronous Motor Field Arcs to Ground

I am having trouble with the field arcing to ground on a synchronous motor rated 500 hp., 5,000 volts, 52 amp., three-phase, 60-cycle, 600 r.p.m. Excitation current at full load is 42.8 amp. Discharge resistor is rated 45 ohms, 22 amp., 600 volts. This motor has always given trouble. It starts under full load, driving pebble mills, and the field current jumps to ground near the squirrel-cage winding, about ½ in. away, about the instant that the compensator is thrown from the start to the running side. The field is applied by a knife switch. I have tested for grounds but found none. Resistance is not open. All connections from terminals have been checked. Heavier endrings were placed on the squirrel-cage winding since the original rings became so hot on starting that eventually they cracked. Would decreasing the discharge resistance tend to reduce the arcing? If so, how much could the resistance be reduced? I should like to know whether anyone else has had this trouble, and what he did to remedy it.

H. C.—Saginaw, Mich.

Corrosion of Plating Barrel Bearings

Rapid corrosion of the cast-iron bearings and trunnions of our plating barrels is causing much trouble and expense. The bearings are immersed in the plating solutions. We plate parts with copper, nickel, zinc, cadmium, or brass, and the fact that corrosion of the bearings seems to be equally rapid in all of these solutions would appear to indicate that electrolysis is the primary cause of the trouble. I wish that readers who have solved this problem would tell me how they did it. Would there be any advantage in making these bearings of some corrosion-resisting metal, such as Monel metal or stainless steel?

W.J.C.—New Britain, Conn.

What Cost Floor Maintenance?

What does it cost to maintain floors? Reply should give the cost in dollars per sq.yd. per unit of time, specifying kind of floor, severity of usage, period over which data were taken.

R.A.N.—Akron, Ohio

· FACTORY FORUM ·

A new question is presented herewith, and readers' discussions of previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

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More or Fewer Records?

Frank Fulleger is visiting George Shipman at the latter's plant.

* * *

"Reduced your clerical force haven't you, George? Looks like a lot of extra space around."

"Yes, there aren't so many people. Less business caused some layoffs. But there's another reason, too; we don't keep as many records as we did. I think the old depression taught us something there. You remember the big stock record we used to keep? That's away down, because we've learned how to operate with a much smaller inventory. And we've simplified, too. Surprising how many forms and clerical records can be cut out if you get down to it."

"You're speaking of production records, I take it, George. I've had just the other experience. So far as plant operation and maintenance go, I've found more records necessary. I've instituted records for inspection, repairs, replacement, and power consumption. I'm keeping labor records, too, for incentive payment."

"I won't quarrel with you about maintenance records, Frank; but on the production end I'll bet your plant's down on records, too. Just look it up, when you go back; see what you've done on records of raw and finished stock, materials in process, time, cost, sales, and so on. See if you don't have the same depression situation that we have—and that you're better off because of it, incidentally."

* * *

No room for further argument between Frank and George. But the experiences of Factory Management and Maintenance readers may differ. Are these men on the right track?

More or Fewer Records?

ANSWERS TO PREVIOUS QUESTIONS

What Will a Shorter Day Mean to Maintenance?

(Question presented in the June issue)

PLANT executives having to do with maintenance functions will, in general, find a real opportunity to apply more efficient methods of performing maintenance tasks.

It behooves the executive to classify the tasks to be performed by the maintenance department, in order that approximations of the overall increase or decrease in cost may be made. Building maintenance, fire protection, and accident prevention likely will continue to demand approximately the same expenditures as in the past. Oiling, belt repair, and preventive maintenance inspection should vary with the hours of production. So should mechanical and electrical repairs and replacements that depend upon the amount of machine operation. It follows that the cost of maintenance, in a broad sense, will not be reduced in exact proportion to the operating hours of the plant.

The short working day certainly favors maintenance work by permitting repairs to be made by daylight. In cases where trouble develops that is not sufficiently serious to warrant immediate shut-down, the shorter production day will enable the maintenance department to attend to the work at an earlier time than if long hours were in vogue.

Where it is apparent that millwrights, pipe-fitters, and electricians can work to much better advantage when department machinery is not in motion, it will be found quite an advantage to have groups begin work at different hours; this scheme not only affords repair service during the operating hours and less hazard to the repair man, but also affords an economy in supervision where the foreman is on a salary basis.

The introduction of a shorter production day will

offer a challenge to maintenance—an opportunity to put into effect those fundamentals that constitute good practice, as well as particular schemes that may be applicable only to the plant in question.

H. D. WERNER, *Plant Engineer*
Lovell Manufacturing Company
Erie, Pa.

Buy or Make Replacement Parts?

(Question presented in the July issue)

TO MAKE or buy replacement parts depends mainly upon the design and specifications of the parts to be replaced. It might be unwise, for example, for a manufacturing concern using shearing equipment to tolerate the time and cost required to secure from the manufacturer a bolt for holding the shear blade in place. On the other hand, the user might, and probably would, meet with all kinds of difficulties trying to manufacture a shear blade.

Naturally, the factors of cost, waiting time, and keeping one's own shop busy represent important items. At the same time, the successful business executive will recognize that behind the firm from which he may buy replacement parts are usually many years of research and development work, and because of this, he stands to profit not only in one but in many ways.

HERBERT D. HALL, *Manufacturing Engineer*
Westinghouse Electric & Mfg. Company
Sharon, Pa.

THE ANSWER depends upon the answers to these questions: What are the maker's skill, materials, tools, and other equipment? Is it impossible to secure reasonable service from manufacturer?

Our principal business is the repair of electric motors and control equipment. We do not manufacture repair parts, unless there is an emergency, and even then, if possible, we lend a motor.

It is too much of a risk to send out a motor with a part that may be just an imitation of the maker's, but with materials that may not be the same, or with some of the closer dimensions probably inaccurate, because of wear of the old part.

The cost of factory parts made under production conditions, often with special machinery, usually is lower than the cost of parts made singly. I find it true as to brush-holders, brush springs, and other small parts of single-phase motors. Often special materials are used, and only the manufacturer knows what they are.

There are exasperating delays, but they do not occur often. When they do occur there usually is some relation to special equipment.

When ordering parts we pay especial attention to giving all details of nameplate reading, and if dimensions are in order they are given. If possible, we secure a parts list and order by numbers, giving also the numbers of the list and the page. If the manufacturer has a representative in the city we call him. You cannot blame the manufacturer for your own employees' mistakes.

GRADY H. EMERSON, *Owner*
Emerson Electric Company
Birmingham, Ala.

THE STORY of the women who will spend 10 or 15 cents carfare to go downtown where they can get a $1 item for 98 cents is a classic. The story of the man who took a short cut of 150 miles when the "long" route was only 40, is almost as good.

But neither of these follies is quite as foolish as the "business man" who will set out to produce replacement parts without more than an iota of the equipment, knowledge, or technical experience needed.

Certainly there are waits in deliveries; of course the prices are sometimes exorbitant; correspondence does sometimes run into reams; mistakes are made; styles do change. But, the guaranty of a reliable manufacturer, the knowledge that the manufacturer knows his business and has done his best with the parts in question—are such items to be measured in terms of dollars and cents? Are things such as these to be weighed in the scale with occasional high prices, useless correspondence, or inconvenient mistakes?

Even if a part costs twice as much when bought; even should the style change the next day; though delivery is delayed; though mistakes are made—still the part is cheaper, a thousand times cheaper than one made by an amateur mechanic with an amateur mechanic's lack of facilities and ability.

FRED BENNETT, *Superintendent*
Standard Products Company
Cleveland, Ohio

I AM IN favor of buying all replacement parts possible, because the makers of apparatus today are prepared to furnish them promptly, and they fit the apparatus they are intended for. The makers are continually finding better ways to make parts and, in buying, you get the benefit of their improvements.

By buying replacement parts, you avoid a lot of pitfalls, such as using the wrong material, misfits, and so on.

The making of your own replacement parts (on anything but a small scale) will certainly lead to serious delays in production if carried over a period of time, in that you will find that misfits have been placed on the machines and have caused trouble to other parts.

In electrical equipment, such as control apparatus, motors and generators, no end of trouble has been caused by misfit control fingers, contacts, improperly wound coils. One of the most important, but greatly slighted in the past, was the application of the improper brushes on generators and motors.

We should also give the maker the benefit of any doubt as to material and design, because, after all, the prosperity or downfall of his business depends on the quality of the parts and the service he renders the buyer.

JOSEPH C. LOOSER, *Maintenance Engineer*
Scovill Manufacturing Company
Waterbury, Conn.

Correction

In this department, in last month's issue, we published a discussion by J. R. Ridpath of the Chase Bag Company of Milwaukee. Through an error we gave his title as "Secretary-Treasurer of the Chase Bag Co." The title should have read "Secretary-Treasurer of the Milwaukee Chapter of the Society of Industrial Engineers."

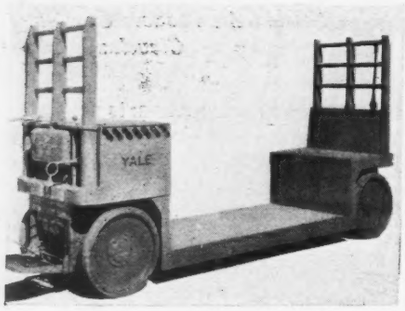
· EQUIPMENT NEWS ·

Relays

Type C7. Contact ratings (for non-inductive circuits): 15 amp. at 110 volts, a.c.; 8 amp. at 220 volts, a.c.; 10 amp. at 115 volts, d.c.; 2 amp. at 230 volts, d.c. Two-circuit control possible with dual-contact feature. Bakelite base $2\frac{1}{2}$x$2\frac{3}{4}$ in. May be furnished for back-connected switchboard mounting. Signal Engineering & Mfg. Co., 154 W. 14 St., New York, N. Y.

Electric Truck

"The Baggage-Master," primarily intended for railway terminal use, has double-reduction, spur-geared drive. Double-end control with interlocking-type controller. Four speeds in either



direction. Heavy rubber bumpers and automatic couplers at both ends for hauling trailers. Wrought-metal electric-welded frame, spur-gear power axle, 27-in. diameter wheels mounted on Timken roller bearings. Electric dynamic brake can be furnished for severe grades. Yale & Towne Mfg. Co., Philadelphia Division, Philadelphia, Pa.

Screen

Self-cleaning, bar-type, completely automatic. Has no cross members within channel, no sprockets or shafts at bottom. Chain floats around large radius curves in guides. Hinged scraper to prevent jamming of mechanism through accumulation of material at bottom of channel. Rake teeth pass through screen with motion designed to pull stones out of screen instead of pushing them through. Shear pins permit release of mechanism without damage when obstruction is encountered. Unit equipped with anti-friction bearings. The Jeffrey Mfg. Co., Columbus, Ohio.

Controller

Style R1 drum switch, $\frac{1}{2}$ hp., for reversing small motors, and for starting and stopping where accurate control is important. Frame of one-piece heavy-gage steel. Top of drawn steel with flange for drip-proofing. Spindle insulated with Bakelite. Rotor contacts of hard rolled copper, locking in place but removable. Fingerboards of laminated Bakelite. Cover lined with asbestos. Furnas Electric Co., West Allis, Wis.

Sprinkler System

"Sprinkler Watchman" permits either wet- or dry-pipe sprinkler systems to be connected directly with municipal fire department through Gamewell municipal fire alarm box of master type. In event of fire, opening of sprinkler head causes fire alarm box to be tripped and alarm furnished to fire department. Also "Sprinklarm," which operates on drop in pressure in wet-pipe lines caused by opening of sprinkler head, to transmit alarm to municipal fire department. The Gamewell Company, Newton, Mass.

Switch

EM-50, subway, oil, for 7,500-volt service. Water-tight. Suitable for wall mounting in subway or manhole, or in locations where there is danger of flooding. Furnished with single-conductor cable sleeves or multi-conductor cable bell, both of cone-shape construction. Operating handle directly connected to mechanism through stuffing box which carries position indicator. Oil tank equipped with oil gage, filling plug and drain plug. Furnished manually operated, non-automatic, 2-, 3- and 4-pole single-throw, and 2- and 3-pole double-throw for 200 and 400 amp. at 7,500 volt. Condit Electrical Mfg. Corp., Boston, Mass.

Electrodes

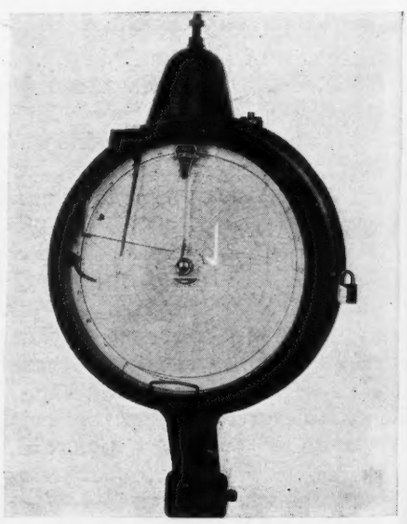
For welding Cromansil steel and Chrome-Molybdenum steel. Cromansil electrode gives deposit of same analysis as parent metal, said to have equal physical properties. Other addition to Murex line deposits metal containing 4 to 6 per cent chromium and 0.5 per cent molybdenum. Metal & Thermit Corp., 120 Broadway, New York, N. Y.

Coupling

"Falk-Rawson 4-Duty." Designed to start, couple, cushion and limit load. Said to reduce inrush current and allow selection of smaller motors operating closer to maximum capacities, eliminate need of shear-pin couplings. Construction involves two drum-shaped members, one attached to driving, other to driven shaft. Between driving and driven members are inserted two sets of floating segments, made of brake lining reinforced with lead, to give centrifugal pressure for carrying load. The Falk Corp., Milwaukee, Wis.

Meter

Bell-type, for measuring flow of gas or air at low pressures. Capacity, 100,000 cu.ft. per hr. Same meter

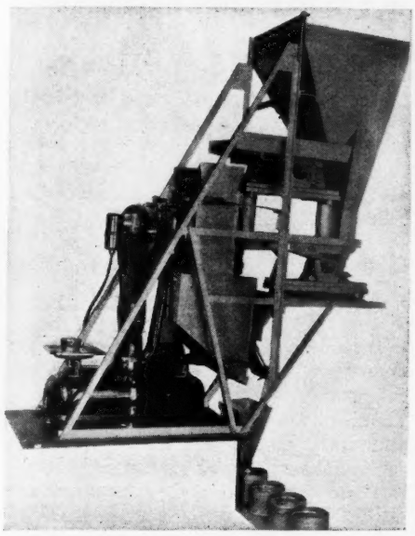


adaptable to greater or less capacity by changing orifice plate. Furnished with orifice plate, pilot tube, flow nozzle or venturi tube. Ranges of 2.5, 5, and 10 in. water differential can be furnished. The Foxboro Co., Foxboro, Mass.

Spray Gun

Type SG-513, designed for applying "Flock" in finishing card tables, trays, caskets, shoe heels, toys, window displays, metal boxes, radios. Dry flock is sprayed on with Type SG gun following coat of adhesion enamel and coat of flock sizing lacquer sprayed on with standard spray gun. Operates to best advantage on 30 lb. air pressure, consuming 7 to 8 cu.ft. of air per min. DeVilbiss Co., Toledo, Ohio.

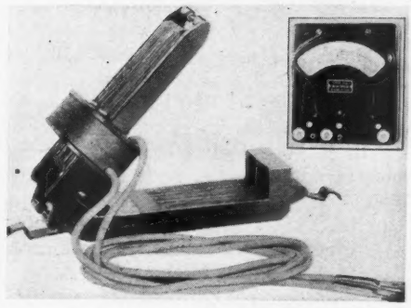
Weighing and Filling Device



Automatic, with capacity for weighing as high as 1,000 1-lb. packages an hour to an accuracy of $\frac{1}{16}$ oz. All drafts are net weights. Device is electrically interlocked against inaccuracies due to mechanical fault. Self-checking. Toledo Scale Co., Toledo, Ohio.

Ball Bearings

"Pigmy" N-463, and 4666. Designed for rotating and oscillating loads, in precision instruments, scales, relays and similar light applications where accuracy and sensitiveness are essential. N-463 has $\frac{1}{8}$-in. bore and $\frac{3}{8}$-in. outside diameter. Type 4666 has $\frac{7}{16}$-in. bore and $\frac{1}{2}$-in. outside diameter. Both are precision units containing respectively, 12 and 17 balls of $\frac{1}{16}$-in. diameter, with inner and outer rings ground and finished. Norma-Hoffmann Bearings Corp., Stamford, Conn.



Test Set

Consisting of Type CSO split-core transformer with either Type PA or Type Steel-Six ammeter. Gives a.c. ampere readings as low as $\frac{1}{2}$ amp. and as high as 200 amp. Ammeter designed especially for use with Type CSO transformer, but may be used separately as self-contained instrument having two ranges, 2.8 amp. and 15 amp. With transformer, has two additional ranges, 40 amp. and 200 amp. Circuit to be tested need not be opened when using transformer. Roller-Smith Co., 233 Broadway, New York, N. Y.

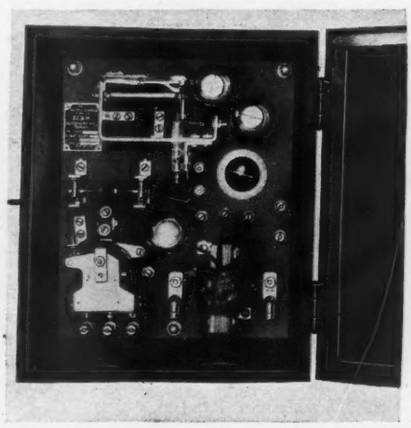
Drawbridge

For cross-overs in industrial plants. Electrically operated by remote or spot control, or counterbalanced for hand chain operation if desired. The Kinnear Mfg. Co., Columbus, Ohio.

Weld Timer

Automatically varies time of weld in inverse proportion to rate of current flow to compensate for fluctuations in line voltage, condition of electrodes, variations in thickness of material, amount of rust, dirt, and scale.

Consists of rectifier tube which changes fixed condenser in proportion to rate of current flowing in welding circuit. When charge reaches amount sufficient to pass current through two neon-gas-filled tubes, small relay is operated which in turn opens the relay controlling main line contactor. The Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio.



Resistance Measuring Device

Type "C" Ground-Ohmer, with ranges 0-10, 0-100 and 0-1,000 ohms, replaces Type "B" with same ranges and older Type "A" with ranges 0-25 and 0-250 ohms. Weight reduced from 32 lb. to 20 lb. Sensitivity said to be almost five times as great as former types. D'Arsonval galvanometer has sensitivity of 1 micro-amp. per division. Generator supplies 2.5 watts at 100

volts, 75 cycles corresponding to 180 r.p.m. of crank handle. Herman H. Sticht & Co., 27 Park Place, New York, N. Y.

Gage

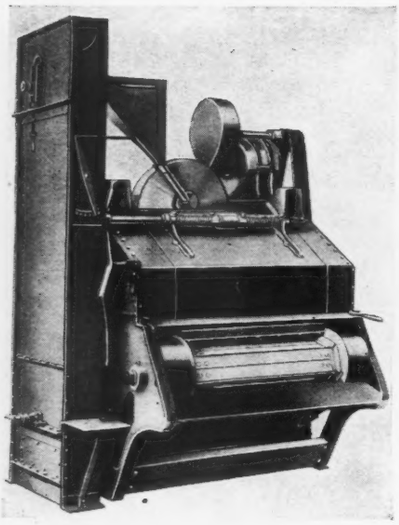
Two-in., indicating, 270-deg. scale. Known as Model "DH." Uses a full-length Bourdon spring for reduction in movement multiplication. Maker announces as accurate to within 1 per cent of total scale. Connection may be at top, bottom, left or right side. Furnished for any range from 0-15 to 0-300 lb. per sq.in., as well as 0-30 in. mercury vacuum. The Foxboro Co., Foxboro, Mass.

Oilers

Automatic. "Constant level," for use on electric motor bearings and other reservoir bearings with oil-ring, packing, or ball or roller bearings where oil in reservoir should be maintained at predetermined level. Tube permits air to enter and oil to flow from reservoir when level of oil in bearing reservoir drops below fixed and proper level—automatically stopping flow of oil when level is attained. "Thermal" oilers, designed for use on sleeve bearings of open type, are wholly operated

by change in bearing temperature. Heat in bearing causes expansion of air in thermal chamber, forcing small quantities of oil to bearing. Both types have visible oil supply. Speedway Mfg. Co., 1834 S. 52nd Ave., Cicero, Ill.

Casting Cleaner



"Airless Wheelabrator" employs centrifugal, tangential, and air-dynamic forces for abrasive cleaning of castings, shapes, sheets, billets, slabs, and forgings. Abrasive is fed by gravity from a storage hopper into the "Wheelabrator" from which it is ejected against the object being cleaned. Works at atmospheric pressure. Power required, 10 hp. No air compressor needed. American Foundry Equipment Co., Mishawaka, Ind.

Wood Flour

Lumber Bi-Products, Inc., 702 M. & T. Bldg., Buffalo, N. Y., has established a Wood Flour Division, recently purchasing assets of former New England mills at Manchester, N. H.

Unit Coolers

Type "FC" suspended unit cooler has extended copper coils suitable for cold water, brine, methyl chloride, and freon. Type "FS" has extended-surface steel coils, hot galvanized after assembly, for use with ammonia. Hang from walls or ceiling. Adjustable louvers to eliminate entrained moisture. Available in various sizes and capacities. Also four types of floor and flat suspended coolers with galvanized casings and drip pans. Fan housings, wheels and outlets painted with asphaltum to resist corrosion. Buffalo Forge Co., Buffalo, N. Y.

Welding Equipment

Spot. For use with either 110- or 220-volt a.c. Requires no special wiring. Weight 26 lb. Claimed able to weld all sizes of sheet metal and wire up to 18-gage and to weld this thickness to much heavier gage metal. 220-volt type water cooled, 110-volt type can be. Floor switch allows operator to use both hands. Superior Pattern & Mfg. Co., Detroit, Mich.

Geared Motor Reducer

"Vari-Speed" unit in open and inclosed types. Infinite speed variation. Self-contained. Speed change obtained by turning hand-wheel without stopping machine. V-Belt drive. Furnished in a variety of ratings, ratios, and combinations. Sterling Electric Motors, Inc., Los Angeles, Calif.

Valve

"Minard Economy" air valve, formerly made and sold by National Sales Engineering Corp., has been redesigned and is now made and sold by Detroit Tool & Forge Co., 656 Smith Ave., Detroit, Mich.

Hydro-Power Unit

For facilitating application of H-P-M radial oil-pressure pump to hydraulically actuated machines. Each unit incorporates radial pump pressure generator, direct driven from electric motor through flexible coupling. Completely inclosed to serve as reservoir for oil used as pressure fluid and lubricant. Reservoir fitted to take copper coils for cooling water circulation when operating conditions require auxiliary oil temperature regulations. Pressure output of pump, regulated by automatic control, from operating limits up to 3,000 lb. per sq.in. Minimum-pressure pump with capacity up to 1,500 lb. per sq.in. also available. For initial work or closing movements, performed at low pressure, 2-stage hydro-power unit available. Incorporates high- or medium-pressure radial pump plus low-pressure rotary pump to provide larger volume for initial portion of operation. The Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.

Switchboard Instruments

Types AD-6 and DD-6. Rectangular. Scale can be read at an angle with no error of parallax. Antiglare glass. Magnetic damping. Available in three styles of cases. Line includes: a.c. voltmeters, ammeters, wattmeters, power-factor meters and frequency meters, and d.c. ammeters and voltmeters. Temperature meters and radio-frequency and rectifier-type instruments also available. General Electric Co., Schenectady, N. Y.

Wire and Wire Products

American Chain Co. and associate companies will take over drawing, fabricating, and sale of Allegheny metal and other Allegheny alloys in round, flat and shaped wire forms. To be marketed under name of Page-Allegheny alloys, and sold by Page Steel & Wire Co., Monessen, Pa. Wire rope from these alloys will be made in the plant of Hazard Wire Rope Co., Wilkes-Barre, Pa. Chains and chain attachments at American Chain Co. plant, York, Pa.

Correction

In the center of page 293, July issue, the item beginning "'Condor Whipcord' transmission" was erroneously titled "Belt Treads for Stairs." It should have been simply "Belt."

TRADE LITERATURE

ABRASIVE CLEANER — Folder, "Airless Wheelabrator," describes a method and equipment for cleaning castings, shapes, billets, sheets.—American Foundry Equipment Co., Mishawaka, Ind.

ACID AND WATERPROOFING COMPOUND—Leaflet, "Stonhard Announces a New Product—Stonhide."—Stonhard Co., 401 N. Broad St., Philadelphia, Pa.

(Continued on advertising page 38)

Data Sheet

Industrial Piping

A TENTATIVE standard for wrought-iron and wrought-steel pipe, dated June, 1933, proposes a new basis for classifying pipe. The old designations of wall thicknesses—standard, extra heavy, and double extra heavy—are discarded and in their stead are "schedules" which are based on internal pressure divided by the safe fiber stress times 1,000.

The formula as a whole is:

$$t = \left(\frac{P}{S} \times \frac{D}{1.75}\right) + 0.1, \text{ in which:}$$

P = internal pressure, lb. per sq.in.
S = safe fiber stress, lb. per sq.in.
D = outside diameter of pipe, in.
t = wall thickness, in.

In general, the fiber stresses specified are: Bessemer steel, 50,000 lb.; open-hearth steel, 45,000 lb.; wrought iron, 42,000 lb. per sq.in. With seamless pipe of open-hearth steel the safe stresses are as high as 60,000 and 75,000 lb. per sq.in.

Table I—*"Standard weight" pipe*

Nominal inside diameter	Outside diameter	Approximate thickness	Nominal inside diameter	Outside diameter	Approximate thickness
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
⅛	0.405	0.068	2½	2.875	0.203
¼	.540	.088	3	3.500	.216
⅜	.675	.091	3½	4.000	.226
½	.840	.109	4	4.500	.237
¾	1.050	.113	5	5.563	.258
1	1.315	.133	6	6.625	.280
1¼	1.660	.140	8	8.625	.322
1½	1.900	.145	10	10.750	.365
2	2.375	.154	12	12.750	.375

Table II—*"Extra-strong" pipe*

Nominal inside diameter	Outside diameter	Approximate thickness	Nominal inside diameter	Outside diameter	Approximate thickness
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
⅛	0.405	0.095	2½	2.875	0.276
¼	.540	.119	3	3.500	.300
⅜	.675	.126	3½	4.000	.318
½	.840	.147	4	4.500	.337
¾	1.050	.154	5	5.563	.375
1	1.315	.179	6	6.625	.432
1¼	1.660	.191	8	8.625	.500
1½	1.900	.200	10	10.750	.500
2	2.375	.218	12	12.750	.500

Table III—*"Double extra-strong" pipe*

Nominal inside diameter	Outside diameter	Approximate thickness	Nominal inside diameter	Outside diameter	Approximate thickness
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
½	0.840	0.294	2½	2.875	0.552
¾	1.050	.308	3	3.500	.600
1	1.315	.358	4	4.500	.674
1¼	1.660	.382	5	5.563	.750
1½	1.900	.400	6	6.625	.864
2	2.375	.436	8	8.625	.875

The object of the new classification is to simplify the manufacturing end of the pipe industry and to limit the endless variety of thicknesses now specified by users.

The present standard and extra-heavy pipe sizes are retained. The double extra-strong sizes are left out of the classification schedules, but will be manufactured. Users will be safe in ordering as at present except where very high pressures are contemplated.

In March, 1933, the U. S. Department of Commerce, Bureau of Standards, issued a bulletin (R 57-32) on standard pipe, valves, and fittings, as a step in its simplified practice program. The tables below, taken from the above publication, differ in no way from the present accepted standards and for the purposes of these data sheets the present nomenclature of standard extra strong and double extra strong will be retained. The adoption of the new classification will be a matter of years.

The formula given above was for determining the wall thickness of a pipe, the pressure and fiber stress being given. The following formula is for ascertaining the bursting pressure of pipe with a known wall thickness, and is a check on the first one:

$$P = \frac{2\,TS}{D}, \text{ in which}$$

P = bursting pressure, lb. per sq.in.
T = thickness of pipe wall, in.
D = outside diameter of pipe, in.
S = tensile strength of material, lb. per sq.in.

Aluminum—Still another variation of the formula is the one used for aluminum pipe; it is:

$$P = S\,\frac{D^2 - d^2}{D^2 + d^2}, \text{ where:}$$

P = safe internal pressure, lb. per sq.in.
S = safe working stress, lb. per sq.in.
D = outside diameter of pipe, in.
d = inside diameter of pipe, in.

In arriving at S in the formula a value of 3,000 is used, giving a factor of 4 at 75 deg. F.

Brass and Copper Tube—Copper and brass tube has a wall thickness equal to standard pipe, minus the depth of thread, and is used with compression or sweated fittings. Tensile strengths are 30,000 lb. per sq.in. for soft temper and 50,000 lb. for hard temper. The bursting pressure of 1-in. pipe made from different materials is given by the makers of copper pipe, as follows:

AA lead, 1,100 lb. per sq.in.
AAA lead 1,200 lb. per sq.in.
Steel, iron, 920 lb. per sq.in.
Copper tube, 3,800 lb. per sq.in.
Brass, I.P.S., 5,776 lb. per sq.in.

Brass Pipe—Tensile strength, 30,000 lb. for soft and 50,000 lb. for hard temper. Recommended for highly corrosive waters. Soft-temper pipe is easily bent.

Cast Iron—Available in I.P.S. (iron pipe size) from 1¼ to 12 in. and 40 ft. long. Tensile strength, 22,000 lb. per sq.in. Same wall thicknesses are used for water and gas, but have different bell ends. Used for water, gas, acids, steam.

Cement Lined—Standard cast pipe. In sizes 4 to 12 in.; cement lining is ⅛ in. thick. From 14 to 24 in. it is 5/16 in. thick. Used for corrosive waters and to prevent tuberculation.

Ceramic—A dense, granite-like mass with acid-proof glaze. Resistant to all acids except hydrofluoric. Tensile strength, 1,420 lb. per sq.in.

Hydraulic—In general this is double extra-heavy pipe. Good for 6,000 to 10,000 lb. per sq.in. depending upon size. Tensile strength, 45,000 lb. per sq.in.

(Continued on page 342)

Base Prices—Standard Pipe—For Purposes of Comparison

(In all specific calculations, current prices should be obtained)

	¼-in. Pipe		1-in. Pipe		2-in. Pipe	
	Weight per ft. lb.	Price per ft. Cents	Weight per ft. lb.	Price per ft. Cents	Weight per ft. lb.	Price per ft. Cents
Aluminum	0.294	12.33	0.580	23.20	1.262	49.21
Brass, 67% Cu.	0.911	17.30	1.740	33.06	4.026	76.38
Brass, 85% Cu.	0.938	19.73	1.790	37.74	4.140	87.24
Copper, I.P.S.	0.957	18.87	1.830	36.02	4.230	83.31
Copper tubing	0.344	12.25	0.839	24.75	2.060	58.50
Iron, black	0.840	8.73	1.120	15.97	3.550	32.73
Iron, galvanized	0.840	10.60	1.120	19.34	3.550	40.46
Lead A	1.500	13.13	4.000	30.00	8.500	60.00
Lead AA	2.000	15.00	4.750	35.63	13.750	67.50
Lead AAA	3.000	22.50	6.000	45.00	19.500	83.13
Steel, black	0.850	4.74	1.130	8.22	3.652	17.89
Steel, galvanized	0.850	6.12	1.130	10.56	3.652	23.00
Chrome-Nickel	0.850	100.00	1.130	100.00	3.652	100.00

Data Sheet

Industrial Piping

Size	Aluminum		Brass Bronze Copper	Brass Copper	Cast Iron for Water								Cast Iron	Cement Lined	Ceramic	Chrome-Nickel Iron			Lead	
	Regular	Extra Strong	IPS	Tube	100 Foot Head	200 Foot Head	300 Foot Head	400 Foot Head	500 Foot Head	600 Foot Head	700 Foot Head	800 Foot Head	Threaded	Cast Iron	Glazed	Regular	Extra Strong	Double Extra Strong	AQ E	XL D
1/8	0.269 0.405	0.215 0.405	0.269 0.405													0.269 0.405	0.215 0.405			
1/4	0.364 0.540	0.302 0.540	0.364 0.540													0.364 0.540	0.302 0.540			
3/8	0.493 0.687	0.423 0.687	0.493 0.687	0.375 0.500												0.493 0.687	0.423 0.675		0.375 0.520	0.375 0.549
1/2	0.622 0.840	0.546 0.840	0.622 0.840	0.500 0.625												0.622 0.846	0.546 0.840	0.252 0.840	0.500 0.628	0.500 0.666
5/8																			0.625 0.765	0.625 0.803
3/4	0.824 1.050	0.742 1.058	0.829 1.058	0.750 0.875												0.824 1.058	0.742 1.050	0.434 1.050	0.750 0.906	0.750 0.940
1	1.049 1.315	0.957 1.315	1.049 1.315	1.000 1.125											1.000 1.750	1.049 1.315	0.957 1.315	0.599 1.315	1.000 1.192	1.000 1.232
1 1/4	1.380 1.660	1.278 1.660	1.380 1.660	1.250 1.375									1.278 1.660		1.250 2.000	1.380 1.660	1.278 1.660	0.896 1.660	1.250 1.442	1.250 1.486
1 1/2	1.610 1.900	1.500 1.900	1.610 1.900										1.500 1.900		1.500 2.500	1.610 1.900	1.500 1.900	1.100 1.900	1.500 1.740	1.500 1.776
1 3/4																				1.750 2.024
2	2.066 2.375	1.939 2.375	2.066 2.375										1.939 2.375		2.000 3.000	2.066 2.375	1.939 2.375	1.503 2.375	2.000 2.185	2.000 2.284
2 1/2	2.469 2.875	2.328 2.875	2.469 2.875										2.328 2.875		2.500 3.750	2.469 2.875	2.323 2.875	1.771 2.875	2.500 2.750	2.500 3.000
3	3.068 3.500	2.900 3.500	3.068 3.500			3.000 3.840	3.000 3.900	3.000 3.960					2.900 3.500		3.000 4.375	3.068 3.500	2.900 3.500	2.300 3.500	3.000 3.250	3.000 3.500
3 1/2	3.548 4.000	3.364 4.000	3.548 4.000													3.548 4.000	3.364 4.000	2.738 4.000		
4	4.026 4.500	3.826 4.500	4.026 4.500		4.000 4.840	4.000 4.900	4.000 4.960	4.000 5.040					3.826 4.500	3.750 4.480	4.000 5.375	4.026 4.500	3.826 4.500	3.152 4.500	4.000 4.250	4.000 4.500
4 1/2	4.506 5.000	4.290 5.000	4.506 5.000													4.506 5.000	4.290 5.000	3.580 5.000		
5	5.047 5.563	4.813 5.563	5.047 5.563										4.813 5.563		5.000 6.500	5.047 5.563	4.813 5.563	4.063 5.563	5.000 5.250	5.000 5.500
6	6.065 6.625	5.761 6.625	6.065 6.625		6.000 6.880	6.000 6.966	6.000 7.020	6.000 7.100	6.000 7.190	6.000 7.220	6.000 7.300	6.000 7.380	5.761 6.625	6.750 6.690	6.000 7.500				6.000 6.250	6.000 6.500
7	7.023 7.625	6.625 7.625																		
8	7.981 8.625	7.625 8.625			8.000 8.920	8.000 9.020	8.000 9.120	8.000 9.220	8.000 9.320	8.000 9.420	8.000 9.500	8.000 9.600	7.705 8.625	7.750 9.050	8.000 9.750					
9																				
10					10.000 11.000	10.000 11.140	10.000 11.240	10.000 11.360	10.000 11.480	10.000 11.600	10.000 11.920	10.000 11.940	9.710 10.750	9.750 11.100	10.000 12.000					
11																				
12					12.000 13.080	12.000 13.240	12.000 13.360	12.000 13.500	12.000 13.640	12.000 13.780	12.000 13.940	12.000 14.080	11.590 12.750	11.750 13.200	12.000 14.000					
Limit					48.000 50.520	48.000 50.840	48.000 51.420	48.000 51.920	36.000 39.600	36.000 40.040	24.000 27.500	24.000 27.760	12 in.	24 in. 3/16 in. Limit	12.000 14.000					

Practically the same pipe is for gas, the difference being in the shape of the bell and a slight difference in wall thickness. The same pipe is made in plain and flanged type. Centrifugally cast pipe is approximately 25 per cent stronger for the same sizes. For the same pressures, the wall thickness is reduced 25 per cent.

Limit on bell and spigot cast iron pipe - 84 in.

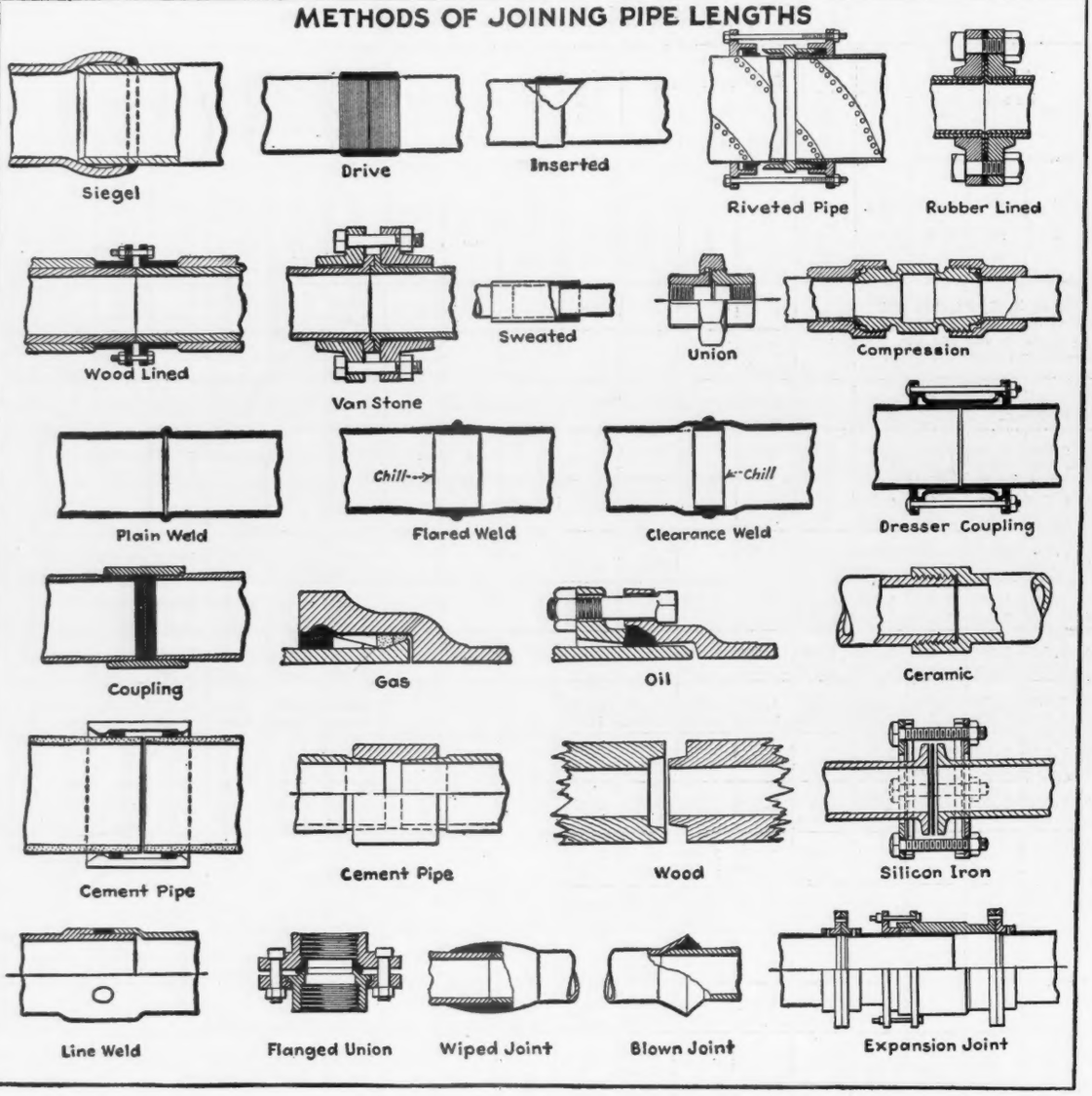
Data Sheet

Industrial Piping

Lead					Lead Lined	Rubber Lined			Silicon Iron	Spiral Riveted			Standard Pipe Classification-O.H. and wrought Iron Five Per Cent Chromium, Iron and Steel			Tin Lined		Transite	Wood Lined	Size
						Hard	Hard	Soft												
L C	M B	S A	XS AA	XXS AAA	Steel	Regular	Extra Strong	Steel		16 Gage	14 Gage	12 Gage	Regular	Extra Strong	Double Extra Strong (Hydraulic)	Steel	Brass, Copper	Cement	Steel, Wood	
AQ, XL, L, M, S, XS, and XXS are Western classifications; E, D, C, B, A, AA, and AAA are Eastern classifications.													0.269 0.405	0.215 0.405						⅛
						0.250 0.540							0.364 0.540	0.302 0.540						¼
0.375 0.577	0.375 0.631	0.375 0.725	0.375 0.811	0.375 0.888		0.375 0.687							0.493 0.675	0.423 0.675	Hy. only 0.187 0.687					⅜
0.500 0.712	0.500 0.750	0.500 0.798	0.500 0.876	0.500 1.012	0.497 0.840	0.500 0.840							0.622 0.840	0.546 0.840	0.252 0.840	0.526 0.840	0.526 0.840			½
0.625 0.881	0.625 0.953	0.625 1.019	0.625 1.082	0.625 1.137																⅝
0.750 1.006	0.750 1.068	0.750 1.156	0.750 1.212	0.750 1.336	0.699 1.058	0.687 1.050							0.824 1.050	0.742 1.050	0.434 1.050	0.730 1.058	0.730 1.058			¾
1.000 1.284	1.000 1.356	1.000 1.428	1.000 1.492	1.000 1.596	0.924 1.315	0.937 1.315	0.750 1.315		1.000 1.750				1.049 1.315	0.957 1.315	0.599 1.315	0.957 1.315	0.957 1.315			1
1.250 1.528	1.250 1.592	1.250 1.670	1.250 1.765	1.250 1.889	1.200 1.660	1.250 1.660	1.000 1.660						1.380 1.660	1.278 1.660	0.896 1.660	1.130 1.660	1.130 1.660			1¼
1.500 1.830	1.500 1.882	1.500 1.984	1.500 2.076	1.500 2.272	1.430 1.900	1.437 1.900	1.250 1.900	1.360 1.900	1.500 2.250				1.610 1.900	1.500 1.900	1.100 1.900	1.485 1.900	1.485 1.900			1½
1.750 2.086	1.750 2.146	1.750 2.193	1.750 2.404	1.750 2.624																1¾
2.000 2.354	2.000 2.410	2.000 2.503	2.000 2.751	2.000 3.008	1.880 2.375	1.875 2.375	1.500 2.375	1.816 2.375	2.000 2.750				2.066 2.375	1.939 2.375	1.503 2.375	1.935 2.375	1.935 2.375	2.000 2.600	2.000 4.000	2
					2.220 2.875	2.250 2.875	1.875 2.875	2.210 2.875	2.500 3.250				2.469 2.875	2.328 2.875	1.771 2.875	2.285 2.875	2.285 2.875	2.500 3.100		2½
					2.820 3.500	2.750 3.500	2.250 3.500	2.818 3.500	3.000 3.875	3.000 3.098			3.068 3.500	2.900 3.500	2.300 3.500	2.874 3.500		3.000 3.640	3.000 7.000	3
								2.998 4.000					3.548 4.000	3.364 4.000	2.728 4.000			3.500 4.140		3½
					3.780 4.500	3.750 4.500	3.000 4.500	3.776 4.500	4.000 4.875	4.000 4.130			4.026 4.500	3.826 4.500	3.152 4.500			4.000 4.640	4.000 8.000	4
								4.256 5.000					* 4.506 5.000	* 4.290 5.000	* 3.580 5.000			4.500 5.200		4½
					4.800 5.563	4.750 5.563		4.897 5.563		5.000 5.130			5.047 5.563	4.813 5.563	4.060 5.563			5.000 5.700	5.000 9.000	5
					5.820 6.625		4.875 6.625	5.815 6.625	6.000 7.000	6.000 6.130	6.000 6.181	6.000 6.218	6.065 6.625	5.761 6.625	4.897 6.625			6.000 6.700	6.000 10.000	6
								6.873 7.625		7.000 7.130	7.000 7.181	7.000 7.218	* 7.023 7.625	* 6.625 7.625	* 5.875 7.625			7.000 7.800	7.000 11.000	7
					7.700 8.625			7.821 8.625	8.000 9.250	8.000 8.130	8.000 8.181	8.000 8.218	8.071 8.625	7.625 8.625	6.815 8.625			8.000 8.800	8.000 12.000	8
								8.691 9.625		9.000 9.130	9.000 9.181	9.000 9.218	* 8.941 9.625	* 8.625 9.625						9
								9.942 10.750		10.000 10.130	10.000 10.181	10.000 10.218	10.192 10.750	9.750 10.750				10.000 10.800	10.000 14.000	10
								10.750 11.750		11.000 11.130	11.000 11.181	11.000 11.218	* 11.000 11.750	* 10.750 11.750						11
								11.750 12.750		12.000 12.130	12.000 12.181	12.000 12.218	12.000 12.750	11.750 12.750				12.000 12.900	12.000 16.000	12
								20 in.			30.000 30.268		Large O.D. pipe, 14 to 16 in., made in thicknesses ¼ to 7/8 in.; 17 to 20 in., the same except ⅜ in.			Special 3 to 5 in.		36.000 38.114	48 in. Limit I.D. 3 in. wall	
										Black and galvanized			*Available, but not on standard list							

Data Sheet

METHODS OF JOINING PIPE LENGTHS



(Continued from page 339)

Lead—Made in seven wall thicknesses. Four thin and three strong sizes. Tensile strength, 3,000 lb. per sq.in.

Lead Lined—For higher pressures than 100 lb. per sq.in., standard steel pipe is lead lined with $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{3}{16}$ in. of lead, dependent upon pipe size. Lead is inseparably bonded to steel and flanged over at end to make a lead-to-lead contact. Used for chemical and corrosive substances.

Open-Hearth Iron—For slight deformations should be worked below 375 deg. F. For Van Stoning should be worked above 1,900 deg. F. The hot-short range of O. H. iron is between 375 and 900 deg. F. and 1,500 to 1,900 deg. F. Used for electrically welded pipe. Tensile strength, from 45,000 to 72,000 lb. per sq.in.

Silicon Iron—Ore contains 14.5 per cent of silicon, 1 per cent of manganese and carbon. Cannot be machined. Resistant to practically every acid and to erosion.

Tin Lined—Standard steel and iron pipe with $\frac{1}{16}$ to $\frac{1}{4}$ in. tin lining. Copper pipe tin lined is standard from $\frac{1}{2}$ to 2 in. diameter.

Transite—A close-grained mixture of cement and asbestos, resistant to corrosion, electrolysis, and tuberculation. Practically impermeable to water. Made in six thicknesses, with working pressures from 21 to 217 lb. per sq.in. Temperature limit, 700 deg. F.

Wood and Wood Lined—Used in paper mills and for water pipes, also as casing for steel pipe. Comparatively low pressures. Spiral riveted pipe is lined with 1½-, 2-, or 3-in. staves for higher pressures.

Spiral Riveted—Bursting pressure 1,860 lb. per sq.in. for 3-in., and 510 lb. for 30-in. pipe. Made from steel 18 B.W.G. (0.049 in.) to 10 B.W.G. (0.134 in.).

Hard Rubber—Same outside diameters as standard and extra-strong pipe. Walls a little thicker. Maximum pressure, 50 lb. per sq.in.; maximum temperature 212 deg. F. Resistant to most acids, but not to ether, benzol, acetone.

Steel, Hard-Rubber Lined—Same tensile strengths as steel and iron pipe, but limited to temperature of 185 deg. F. Inseparably bonded. Rubber-to-rubber contact between lengths.

Steel, Soft-Rubber Lined—Standard steel and iron and spiral riveted pipe. Three classes of lining: Acid seal, for acids and corrosives; Armorite for sand and fluids containing abrasives; and Super-flexite for oils and organic acids. Bond between rubber and metal, order of 500 lb. per sq.in.

Wrought Iron—Tensile strength, 48,000 lb. per sq.in. Is more resistant to corrosion than steel pipe.

Miscellaneous—When all is said and done, so-called standard classifications are largely merely a preferred list of sizes. The sizes given in the table, however, cover the range of requirements and should be specified when at all possible.